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Ectodermal dysplasia – A cephalometric appraisal

V.P. Jalili [a,b,*], H.C. Neema [c]

[a] Director, Post Graduate Studies & Research, Modern Dental College & Research Centre, Indore, India
[b] Former Professor & HOD, Department of Orthodontics & Principal, Govt. College of Dentistry, Indore 452001, India
[c] Former Professor & Head, Department of Conservative Dentistry & Endodontics, Govt. College of Dentistry, Indore 452001, India

Keywords:
Ectodermal dysplasia
Anodontia
Craniofacial growth
Cephalometric

ABSTRACT

Ectodermal dysplasia (ED) is a rare genetic disturbance affecting the tissues of ectodermal origin with mutation carried by X chromosome with partial expression in females and major manifestation in male sex. It often presents problems of partial or total anodontia of one or both the series of dentition. Absence of complete dentition is rare.

During a time span of 10 years, 4 cases (3 females & 1 male) affected with ectodermal dysplasia have been reported. Female subjects showed varying degree of anodontia while the male suffered from complete absence of both primary and permanent dentition.

It is interesting to note a higher ratio of affected females, 3 females against 1 male. Females of course exhibited slight lesser manifestation of ED than observed in male. This is in agreement with phenomena of doses compensation of Lyons Hypothesis.

Cephalometric angular and linear measurements revealed that ED subjects exhibit tendency for mild mandibular prognathism in the females. Linear dimension exhibit lesser dimensions with tendency to retruded maxilla and significant reduction in lower facial height due to hypodontia and absence or poor development of alveolar ridges. It is also interesting to note that only reported female members of their families were affected by ED and none of the parents or other members of their families were affected.

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1. Introduction & review of literature

Ectodermal dysplasia (ED) is a rare form of genetic syndrome with consistent inheritance patterns with a mutation carried by X chromosomes with partial expression in females and major manifestations in male sex. It is inherited by autosomal recessive, autosomal dominant or X linked recessive transmission.[1–3]

ED is known for a triad of clinical findings – hypodontia, hypotrichosis and hypohydrosis. It is often associated with other components resulting from defective development of structures of ectodermal origin. Mckusick[4] analysis of several hundred cases have revealed that the syndrome is transmitted by an X linked recessive trait. The gene being carried by the female and manifested in the male. However there are several reports of females manifesting the complete syndrome.

Patient with ectodermal dysplasia usually show a fine smooth dry skin with partial or complete absence of sweat glands leading to inability to perspire and consequently may suffer from hyperthermia. The hairs of scalp and eyebrows tend to be fine and scanty. The bridge of the nose is depressed and the supraorbital ridges are pronounced. The lips are protuberant because of hypodontia and resultant loss of vertical dimensions. In cases with complete absence of teeth, the alveolar bone does not develop and is hypertrophic. However,

* *Corresponding author*. 5-Mishra Vihar Colony, Near Geeta Bhavan Mandir, Indore 452001, India. Tel.: +91 9425323043.
E-mail address: jpfa@rediffmail.com (V.P. Jalili).

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http://dx.doi.org/10.1016/j.jpfa.2013.07.001

cephalometric studies of Sarnat et al[5] indicate that apart from defective alveolar growth, jaw and facial development is essentially normal. With involvement of tissues of ectodermal origin one would expect that salivary glands would also be affected in ED but this is not a common finding since patients ordinarily do not complain of xerostomia.[6]

The term ectodermal dysplasia was first used by weach[7] in 1929. Willner[8] in 1936 reviewed cases from literature on anodontia and found 5 cases in which both deciduous and permanent teeth were absent and 5 cases in which complete anodontia affected one jaw only whereas other jaw had few teeth. Brodie and Sarnat[9] in 1942 reported a case of ED with complete anodontia where they made a longitudinal cephalometric study of the patient from 12 to 16 years of age and found that linear craniofacial dimension fell within the range of a small normal whereas angular measurement matched the mean of control group. Similarly Cohen[10] in 1950 described 2 cases of ED of which one was a boy and other was a girl. The boy had complete anodontia whereas the girl had 10 erupted teeth and a prognathic mandible. Seagle[11] in 1954 reported two cases of ED from the same family 1 brother and 1 sister. Sidhu and Subherwal[12] in 1968 presented four cases of partial anodontia out of which 2 cases showed abnormalities of ectodermal origin in other parts of the body with missing teeth.

Desai[13] in 1954 reported a case of ED with complete anodontia. Elfenbaum[14] in 1966 illustrated 5 cases – 4 males and 1 female having complete anodontia with ED. Lulit[15] in 1966 reported a 14-year-old girl with 17 permanent teeth missing, cephalometric analysis showed protrusion of mandible by 1° and skeletal age advance of chronological age. Carter and Bordie[16] in 1967 investigated the genetic histories of a related family of ten brothers and sister with their respective offsprings considering the appearance of signs of ectodermal dysplasia and found that the traits in this family were compatible with the Lyon's hypothesis and sex linked and sex modified in females.

Bondarets[17] et al in their cephalometric evaluation of ED in a longitudinal study observed a trend of craniofacial growth towards a retrognathic maxilla and class III sagittal relationship of the jaws. In another recent longitudinal study performed by Dellavia C[18] et al compared the growth of Hypohidrotic Ectodermal dysplasia (HED) young patients with that of healthy reference peers and found a global reduction of all facial volumes in the syndromic subjects during childhood. However they further observed that facial volumes increased their growth by the time and at the end of adolescence the HED subjects had similar growth patterns of facial volumes compared to their reference peers.

Dellavia C[19] et al in a recent quantitative longitudinal study on 12 subjects with HED (6 boys & 6 girls) recorded 3D noninvasive facial measurements at 8, 11, 12 and 15 years age using an electromagnetic digitizers. The linear distances in the upper, middle and lower third of the face were analysed and compared with cross sectional data obtained in normal healthy coetaneous. They found that in the first time span, the growth of all facial measurements was reduced in HED subjects compared with control subjects. Most of the HED children underwent a functional orthodontic and/or prosthetic treatment. Therefore during adolescence, the width and height of the upper and lower facial third showed a larger growth in HED subjects than in control group. While all facial depths and distances in the middle third maintained a reduced growth, they observed that the deviation from normal facial growth of HED subjects tends to lessen with age. They believed that functional and prosthetic appliances may have enhanced facial growth.

In the present study, 4 cases of ED (3 females and 1 male) have been reported. Lateral cephalogram of all 4 cases were taken and analysed to study craniofacial characteristics in vertical as well as anteroposterior dimensions.

2. Case report & findings

During the span of 10 years, 4 cases (3 females and 1 male) reported to the department of orthodontics of Government College of Dentistry, Indore with clinical features of ED. The diagnosis was confirmed through the local Medical College Hospital consultant. No subject had undergone any previous craniofacial surgical procedure or dental treatment. In all 4 cases, clinical examination of mouth and face was carried and family history was explored. In addition to varying degree of anodontia, all 4 cases exhibited manifestations of ED more severe in male than female subjects (Fig. 1a and b).

Case 1
Age/gender: 15 years, female
Community: Sikh
Teeth present: 13, 23 & 24 only. H/o having deciduous teeth (the number not known) which were shed.
Other family members affected by ED: one younger sister (case 2)

Case 2
Age/gender: 10 years, female.
Community: Sikh.
Teeth present: 53, 54, 55, 63, 64, 65, 71, 72, 73, 74, 75, 81, 82, 83, 84 & 85.
X-ray revealed unerupted 23.

Case 3
Age/gender: 16 years, female.
Community: Jain.
Teeth present: 16, 51, 53, 55, 61, 63, 65, 26, 71, 72, 73, 74, 75, 81, 82, 83, 84 & 85.
X-ray revealed unerupted 34, 35, 44 & 45.
Other family members affected by ED: none.

Case 4
Age/gender: 9 years, male.
Community: Muslim.
Teeth present: none. No history of eruption of any deciduous or permanent dentition and had poor ridges with appearance of miniature edentulous old man.
X-ray revealed complete absence of dentition and poorly developed ridges.
Other family members affected by ED: none.

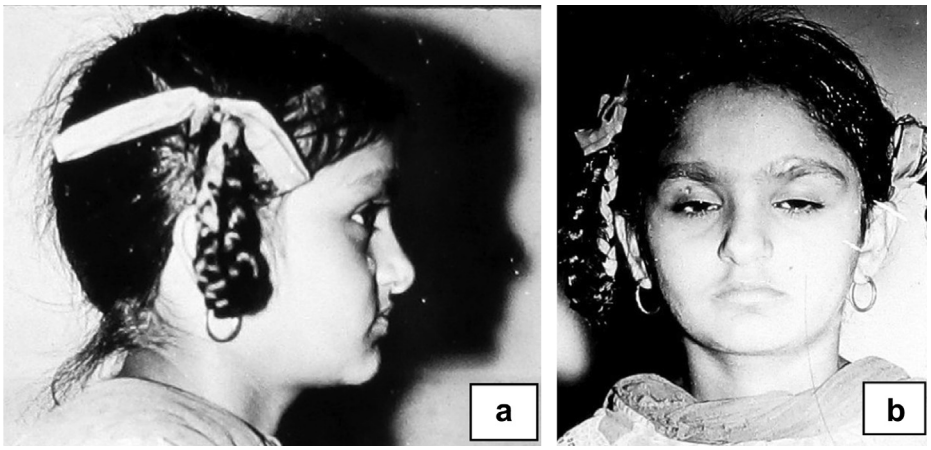


Fig. 1 – a & b: Photographs of ectodermal dysplasia patient (case 2). A female ED patient showing ED manifestations, scanty fine silky hairs on scalp & eyebrows, smooth dry skin, saddled nose, pronounced supero orbital ridges, forehead & chin and reduced lower facial height with everted lips giving a look of a short aged face.

Standardized Lateral Cephalograms of left side were taken (Fig 2–5) and traced to record angular and linear measurements to study craniofacial characteristics. Since the sample size being small and subjects belonged to 3 different communities of Sikh, Jain and Muslim, the data of angular and linear measurements could not be compared with absolute comparable norms. Gross comparisons were carried with the existing norms of Steiner[20] Wylie[21] and Jalili & Sheikh.[22] Angular and linear dimensions were analysed to interpret any deviations from available norms.

Angular measurements were recorded as per Steiners analysis (Fig. 6a) and compared with Steiners norms[20] (Table 1a). For vertical dimension palatal plane was taken as reference line extended forward and a perpendicular was dropped at some distance anterior to ANS. This line (PP) was extended downward. Perpendiculars were then dropped on this PP line from nasion and gnathion. The point where palatal plane met PP line was termed ANS' and where perpendicular from N & Gn met PP line were named N' & G'n respectively (Fig. 6b). The PP line was utilized to measure facial height as under:

1 Total facial height: the vertical distance between the nasion and gnathion measured on PP line between N' and G'n.
2 Upper facial height (nasal height): vertical distance between nasion and anterior nasal spine measured on PP'line between N' and ANS'.
3 Lower facial height: vertical distance between ANS and Gn measured on PP line between ANS' and Gn'.

Vertical facial height and proportions were compared with Indian adolescent norms of Jalili and Shaikh[22] (Table 1b). Anteroposterior dimensions, glenoid fossa to sella, sella to Ptm, maxillary length and mandibular length were recorded following Wylie's method (Fig. 6c) and compared with Wylie's norms[21] (Table 1c & 1d).

Assessment of anteroposterior dysplasia was made as per Wylie's calculations for each subject separately as shown in Tables 2a–2d in order to assess the discrepancies in size of facial bones occurring in anteroposterior plane of space quantitatively in terms of millimeters.

3. Discussion

Craniofacial structures derived from ectoderm and neural crests are often altered in subjects affected by ectodermal dysplasia resulting in a non-harmonious facial morphology with associated functional and aesthetic impairment. It often presents with problem of anodontia of varying degree. In extreme cases there may be complete absence of teeth of one or both the series. If the onset of disturbance in ectodermal tissue occurs in the foetus, after about the 8th week of embryonic life, the primary teeth may form and develop. The teeth that usually appear late and erupt are highly susceptible to caries.[14]

During time span of 10 years, 4 cases of ED reported to the department. 3 were females and one male. All 4 subjects showed varying degree of manifestations of ED, male exhibiting more severe with complete absence of teeth of both series. Out of 3 females, 2 were real sisters of 10 years and 15 years of age belonging to a Sikh family. The third female of 14 years was a Jain. None of the parents or other family members of 3 females & 1 male was affected by ED. Contrary to the findings of other studies, the ratio of male to female subjects affected by ED syndrome in this study come to 1 male to 3 females instead of 5 male to 1 female reported in earlier studies. This difference in ratio of affected males to affected females could be as per the phenomenon of Lyon's hypothesis; the phenomenon of dosage compensation. Carter and Bordie[16] referring to Lyon's hypothesis stressed that only one X chromosome is active in any cell and that any X chromosomes in excess of one are inactivated. As a result there is only one functional X chromosome in both male and female which of the two chromosomes is inactivated in females is purely random. The random X inactivation occur during foetal development. In some cells the maternally derived X



Fig. 2: Case 1

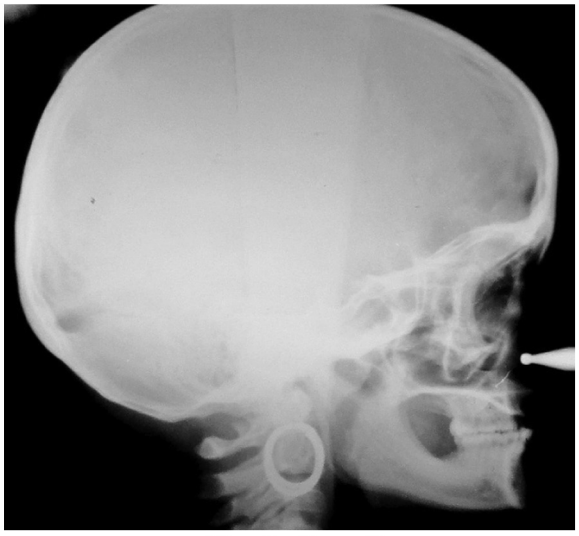


Fig. 3: Case 2

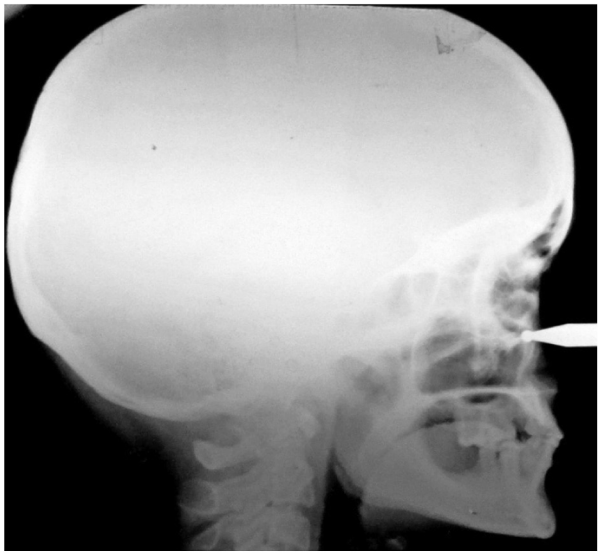


Fig. 4: Case 3

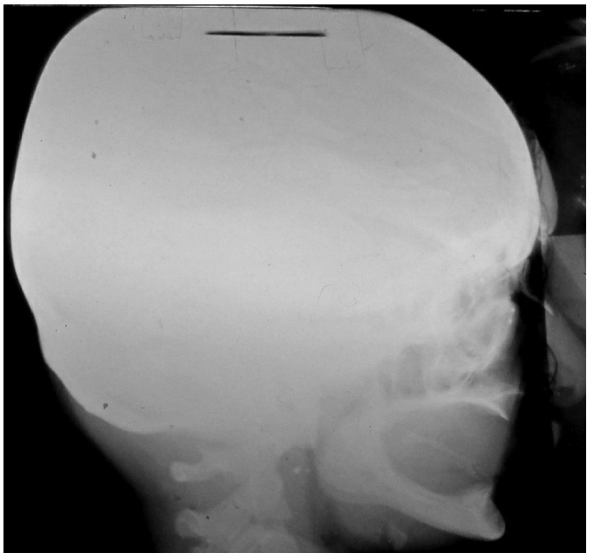


Fig. 5: Case 4

Fig. 2–5 – Cephalograms of three females and one male subject showing reduced dimensions of craniofacial structures, presence of limited alveolar bone in females with varying degree hypodontia (Fig. 2–4) and nearly complete absence of alveolar bone in male subject with normal maxillomandibular relationship (ANB 2°) (Fig. 5). Regrets: Regrets for poor reproduction of cephalogram of fig 5 due to long storage causing fogging.

chromosome is inactivated while in others paternally derived X chromosome is inactivated. X linked ED is an example of random X inactivation in humans.

Cephalometric evaluation of the 4 reported cases show reduced craniofacial measurements, both linear as well as angular with a peculiar trend of craniofacial growth towards a retrognathic maxilla, slight prognathic mandible in three females while in only male both maxilla and mandible though exhibited retrognathic position with significantly reduced < SNA & <SNB measurement < ANB were within normal. These findings are in agreement with those of Brodie and Sarnat[9] and with Lulit.[15] It is observed that though quantitatively all the craniofacial measurements, linear as well as angular are found deficit when compared with standard norms, qualitatively the facial proportions and jaws relationship are not much disturbed except in lower facial region where ratio of lower facial height (ANS-Gn) is reduced due to deficit alveolar bone with complete absence of dentition in male subject and gross hypodontia of permanent dentition in females, leading to protuberant lips and reduced lower facial height.

The above findings are in agreement with those of Johnson[23] et al who found a positive correlation between the number of maxillary missing permanent teeth and craniofacial dismorphology in ectodermal dysplasia children. Male subjects with complete or reverse hypodontia had marked midface hypoplasia with reduced lower and total facial heights.

Elfenbaum[14] as well states that a total dental aplasia leads to poor development of jaws and tissues around the mouth, consequently lower face lacks proper vertical dimension.

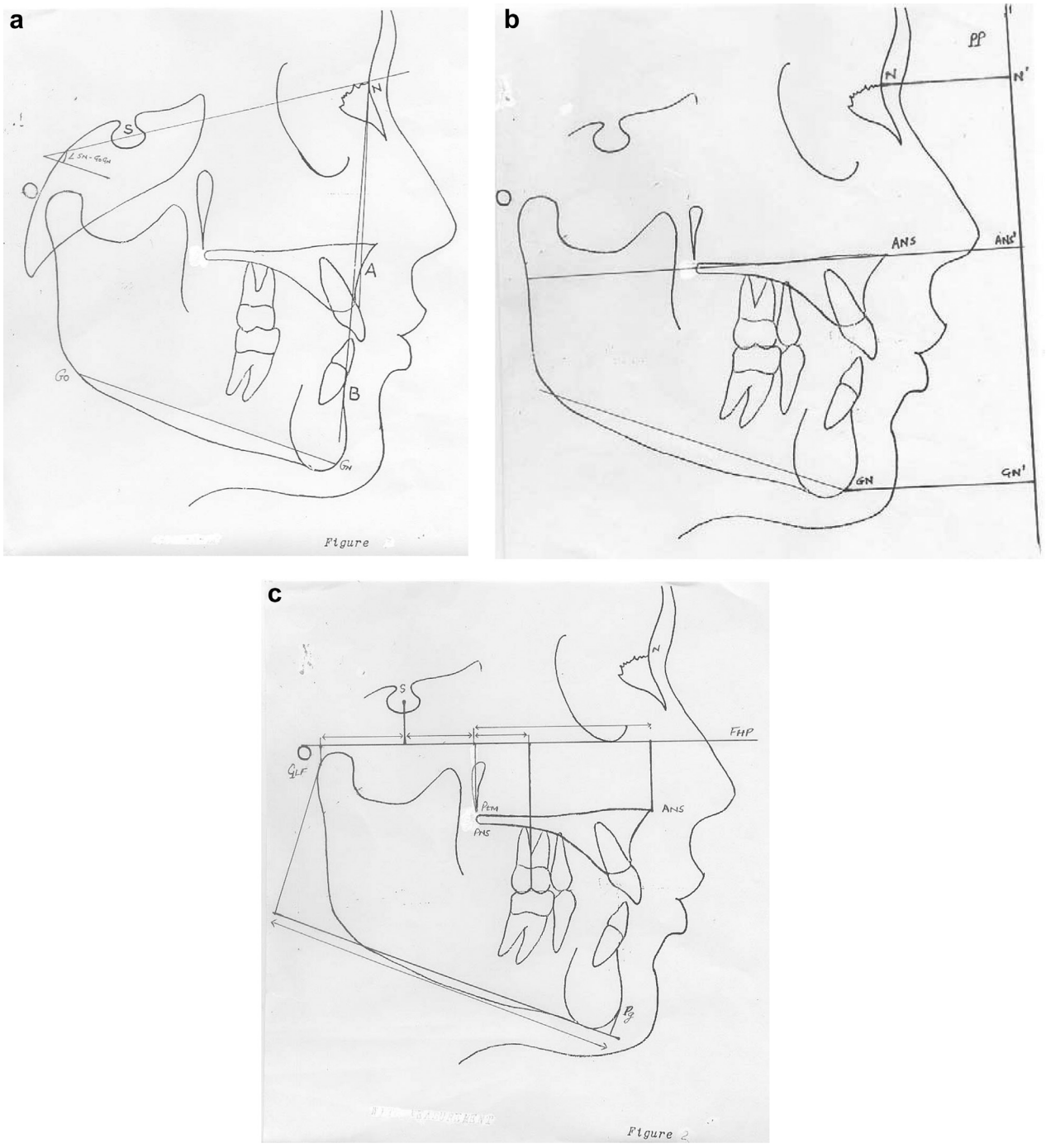


Fig. 6 – a: Angular dimension (Steiner's) <SNA, <SNB, <ANB, <Sn – GoGn. b: Vertical dimension (Jalili & Shaikh) N to Gn, N-ANS, ANS-Gn. c: Anteroposterior dimension (Wylie's) GLF-S, S-Ptm, Max Length, Ptm to 6, Mand length.

While Herzberg & Holic[24] study on vertical dysplasia pointed out that the upper facial height (N-ANS) was a stable area and the absence of teeth did not affect it. It contributed 45% of the total face height. While Wylie & Johnson[25] as well as Jalili & Shaikh[22] endorse Nasal height ratio of 45% to total facial height, Brodie[26] mentions that distance between Nasion and ANS constitute 43% of total facial height.

Assessment of discrepancies in size of facial bones occurring in the anteroposterior plane of space has been made as

Table 1a – Craniofacial angular dimensions.

Dimension	Standard (Steiner)	Case 1	Case 2	Case 3	Case 4
<SNA	82°	73°	74°	73.5°	72°
<SNB	80°	76°	76.5°	75.5°	70°
<ANB	2°	−3	−2.5	−2	2
<Sn – GoGn	32°	22°	19°	30°	28°

Table 1b – Vertical dimensions.

Dimension	Standard (Jalili & Shaikh)	Case 1	Case 2	Case 3	Case 4
N to Gn	111 mm	97 mm	77 mm	97 mm	87 mm
N-ANS	50 mm	44.5 mm	38 mm	47 mm	40 mm
ANS-Gn	61 mm	52.5 mm	39 mm	51 mm	47 mm
Ratio N-ANS to N-Gn	45%	45.8%	49%	48%	46%

Table 1c – Anteroposterior dimensions – female.

Dimension	Standard (Wylie's)	Case 1	Case 2	Case 3
GLF-S	17 mm	17 mm	14 mm	18 mm
S-Ptm	17 mm	22 mm	19 mm	18 mm
Max length	52 mm	52 mm	41 mm	47 mm
Ptm to 6	16 mm	–	–	16 mm
Mand length	101 mm	92 mm	82 mm	90 mm

Table 1d – Anteroposterior dimensions – male.

Dimension	Standard (Wylie's)	Case 4
GLF-S	18 mm	19 mm
S-Ptm	18 mm	15 mm
Max length	52 mm	46 mm
Mand length	103 mm	78 mm

Assessment of anteroposterior dysplasia–Wylie's method.

per Wylie's method to assess the dysplasia quantitatively in terms of millimeters. This method makes it possible to have a net score of anteroposterior dysplasia. A net score would be zero where dysplasia is either nonexistent or compensated for by variation in different parts. It is negative in the type of face where relative mandibular insufficiency exists and positive in cases of mandibular prognathism. Results of this study (Table 2a–c) show negative scoring of −14, −5 and −8 in female case 1, case 2 & case 3 respectively and a score of −17 in the male (Table 2d) eliciting thereby varying degree of mandibular insufficiency in all 3 female and 1 male subjects of ED reported in this study.

Maxillary length and mandibular length have been found deficit in three subjects, 2 females and 1 male of this study. While in elder female amongst two sisters had maxillary length close to normal and slightly better mandibular length than the younger sister.

In this it has been observed that in spite of quantitative deficiencies in craniofacial measurements, the overall measurements gave a picture equal to small normal as stated by Brodie and Sarnat.[9] The male subject exhibited maximum manifestations of ED with a typical "aged face" look associated with reduced maxillofacial dimensions. Skeletal relationship however showed normal class I relationship with <ANB 2°.

Dellavia et al[18] in a longitudinal investigation found global reduction of all facial volumes in the HED subjects compared with reference individuals during childhood, but some improvement in the maxillary and mandibular size were reported by time. This could partly explain the diminished maxillary and mandibular length in younger sister and the male subject who happened to be 9 & 10 years age respectively and younger to other two females of late adolescent age in this study.

As regard to the treatment/rehabilitation of ED patients there is no known treatment for this syndromic condition as such. However early interception and oral and dental rehabilitation has been advised in order to attain more normal and acceptably pleasant facial features.[27]

The different growth mechanism in the two jaws reveals to be different dimensional variations in the two jaws. Maxilla undergoes a sutural growth, while mandible is primarily characterized by endochondrial growth at the condyles. In the ED patients, the mandibular ramus height increases over time but the alveolar bone remains atrophic with consequent low angle vertical height.[28,29]

Studies of Dellavia et al[18,19] confirm that early dental rehabilitation is paramount to enhance the growth potential of facial hard and soft tissue by doing a positive increase in vertical facial growth care be achieved together with improvements in speech, deglutition and mastication. Functional appliances could be useful to modulate jaws growth especially in cases where deciduous and some permanent teeth are present. It is emphasized that an orthodontist monitor functional appliances and dentures frequently with continuous adaptation and replacement during growth.[30,31]

Table 2a – Case 1: female, 15 years.

Dimension	Standard	Patient's	Orthognathic	Prognathic
GLF to Sella	17	17	–	–
Sella to Ptm	17	22	5	–
Max length	52	52	–	–
Ptm to 6	16	–	–	–
Mand length	101	92	9	–
		Total	14	0

Units of anteroposterior dysplasia = prognathic-orthognathic −14

Table 2b – Case 2 female, 10 years.

Dimension	Standard	Patient's	Orthognathic	Prognathic
GLF to Sella	17	14	–	5
Sella to Ptm	17	19	2	–
Max length	52	91	–	11
Ptm to 6	16	–	–	–
Mand length	101	82	19	–
		Total	21	16

Units of anteroposterior dysplasia = prognathic-orthognathic −5

Table 2c – Case 3, female, 16 years.

Dimension	Standard	Patient's	Orthognathic	Prognathic
GLF to Sella	17	18	1	–
Sella to Ptm	17	18	1	–
Max length	52	47	–	5
Ptm to 6	16	16	–	–
Mand length	101	90	11	–
		Total	13	5

Units of anteroposterior dysplasia = prognathic-orthognathic −8

Table 2d – Case 4, male 9 years.

Dimension	Standard	Patient's	Orthognathic	Prognathic
GLF to Sella	18	19	1	–
Sella to Ptm	18	15	–	3
Max length	52	46	–	6
Ptm to 6	15	–	–	–
Mand length	103	78	25	–
		Total	26	9

Units of anteroposterior dysplasia = prognathic-orthognathic −17

4. Conclusion

4 cases affected by Ectodermal dysplasia, 3 females and one male have been reported. A random cephalometric appraisal of their craniofacial dimensions, linear as well as angular have been presented and discussed. Findings of this study have revealed reduced dimensions, both linear as well as angular and are in agreement with available limited crossectional or longitudinal studies on ED subjects by authors earlier as well as in recent years. Due to rare occurrence of this genetic X linked disturbance of ectodermal origin in a time span of 10 years only 4 cases could be spotted. The number of subjects of the study being small and belonging to different 3 communities, results could not be compared with absolute norms related to the population. However, variants were compared with existing standard norms.

Need for an epidemiological with regional studies on congenital developmental anomalies including different types of ectodermal dysplasia to be followed by a longitudinal study of a reasonable sized sample of ED affected subjects, need not be overemphasized. Possibility of stem cell studies on dental lamina generation could also be explored to overcome hypodontic disabilities.

Conflicts of interest

All authors have none to declare.

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