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ELLIS-VAN CREVELD SYNDROME ASSOCIATED WITH COMMON ATRIUM AND A-V CANAL DEFECT-A RARE CLINICAL ENTITY

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ABSTRACT
Ellis Van Creveld Syndrome [EVC] is a rare genetic disorder also as called chondroectodermal dysplasia. It has autosomal recessive inheritance caused by mutation in the EVC gene located on the short arm of chromosome 4. It mainly consists of four components-chondro dysplasia in the form of dwarfism, ectodermal dysplasia mainly in teeth and nail, polydactyly and congenital heart disease. It is commonly seen in the the Amish population of Pennsylvania in USA but also occur in non Amish population with the prevalence around 7/1,000,000 live births. Here we report a case of 12 year old Indian male with classical features of Ellis Van Creveld Syndrome accompanied by complex cardiac defects: common atrium, AV septal defect (AVSD), ventricular septal defect (VSD) and severe tricuspid regurgitation (TR). AV septal defect is an uncommon cardiac malformation, and yet it is commonly found in patients with the EVC.

KEYWORDS: Congenital Heart Disease, Cyanotic Congenital Heart Disease, Common Atrium, Chondro-ectodermal dysplasia, AV Septal Defects, AV Canal Defects, Inlet VSD.

INTRODUCTION

Children with Ellis-Van-Creveld syndrome [EVC] or chondroectodermal dysplasia often manifest growth retardation with association of skeletal abnormalities such as genu valgum, syndactaly, polydactaly, micrognathia, and dental anomalies[1][(Figures 1-5).

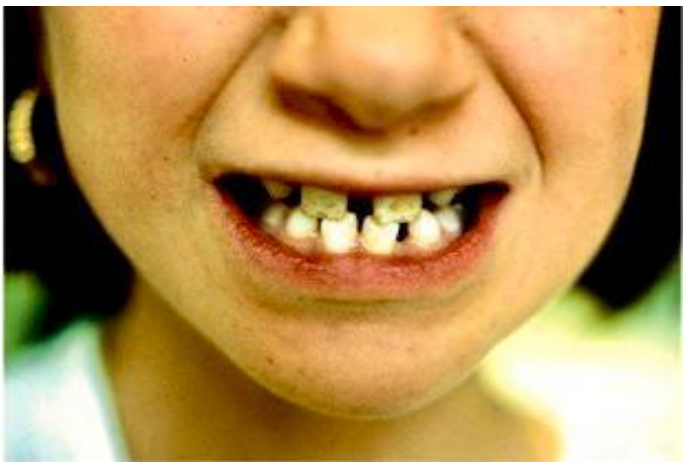


Figure 1: Anterior view of the mouth of EVC patient showing absence of upper incisors and conical lower incisors.

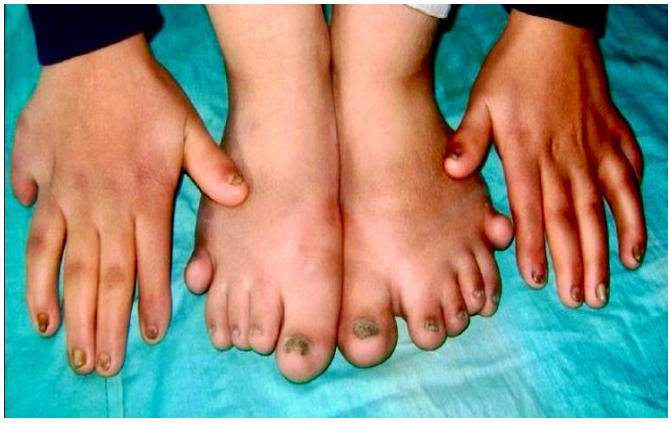
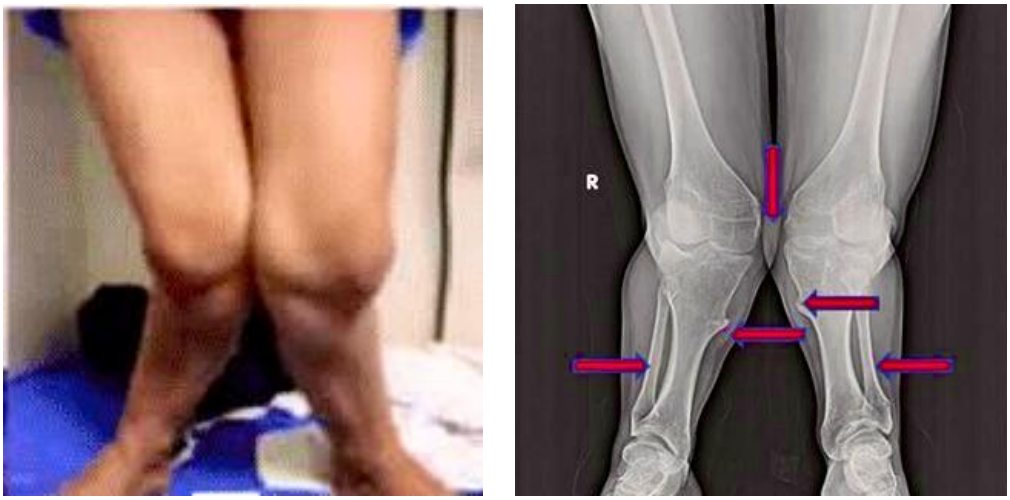
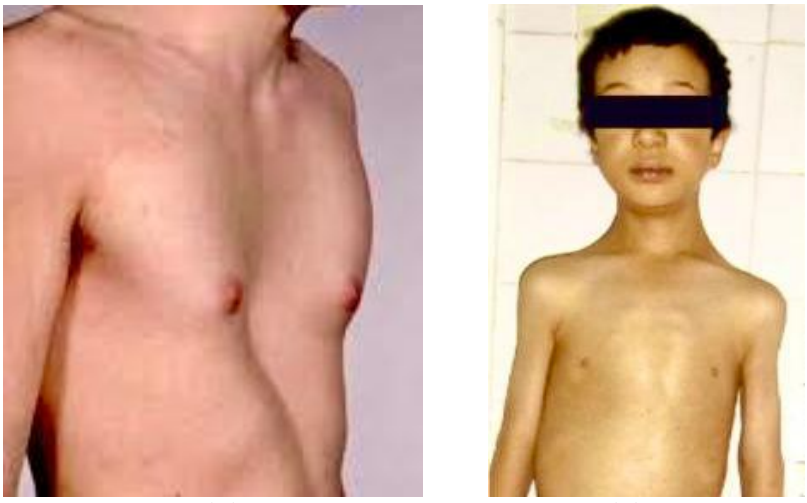


Figure 2: Polydactyly in the hands and feet of an EVC syndrome patient. The patient also has shortened fingers and nail dysplasia.



(A) (B)

Figure 3: (A) Outward bending of knees (genu valgum); (B) Knee joint alignment in genu valgum deformity.



(A) (B)

Figure 4: Chest deformities. (A) Pectus excavatum; (B) Pectus carinatum.

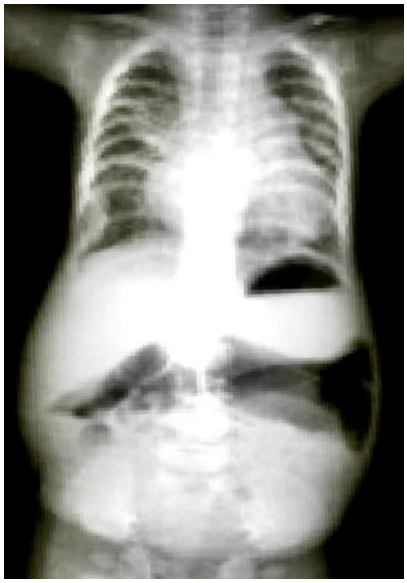


Figure 5: X-ray chest including abdomen showing narrow thorax, patchy opacities in both lung fields with mild cardiomegaly.

Principal clinical characteristics of Ellis-van Creveld syndrome.[2]

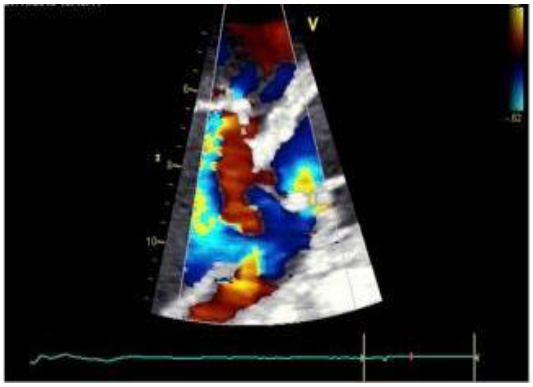
1. Chondrodystrophy (most common)
- Low stature
- Disproportionate distal limb shortening (acromesomelia)

2. Polydactyly (constant finding)
- Hands bilaterally (most cases)
- Feet occasionally

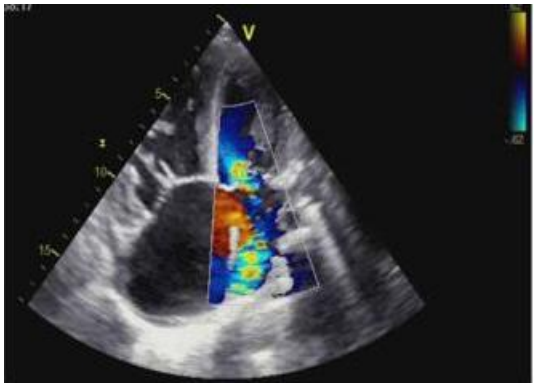
3. Ectodermal dysplasia (observed in many)
- Nails: dystrophic and friable
- Teeth: hypodontia/small and enamel hypoplasia
- Hair: sparse and fine

4. Congenital cardiac anomalies (in 50% cases)
- Atrial septal defect leading to single atrium (most common)
- Complete AV septal defect (CAVSD)
- Partial AV septal defect (PAVSD)
- Patent ductus arteriosus
- Valve defects
- Tetralogy of Fallots

The association of a congenital cardiac lesion in EVC suggests that cardiac defect may be due to a chromosomal disorder inherited by an autosomal dominant trait. The common atrium identified in a patient with (chondro-ectodermal dysplasia) also may indicate that this congenital cardiac anomaly may be due to a chromosomal disorder inherited by an autosomal dominant trait. Common (single) atrium may occur as an isolated entity or is associated with other congenital cardiac malformations such as ventricular septal defect, Tetralogy of Fallot, Ebstein's malformation of the tricuspid valve, heterotaxy syndrome, anomalous systemic and pulmonary venous connections, and atrioventricular (AV) canal defects[1, 3, 4] (Figures 6, 7).



(A)



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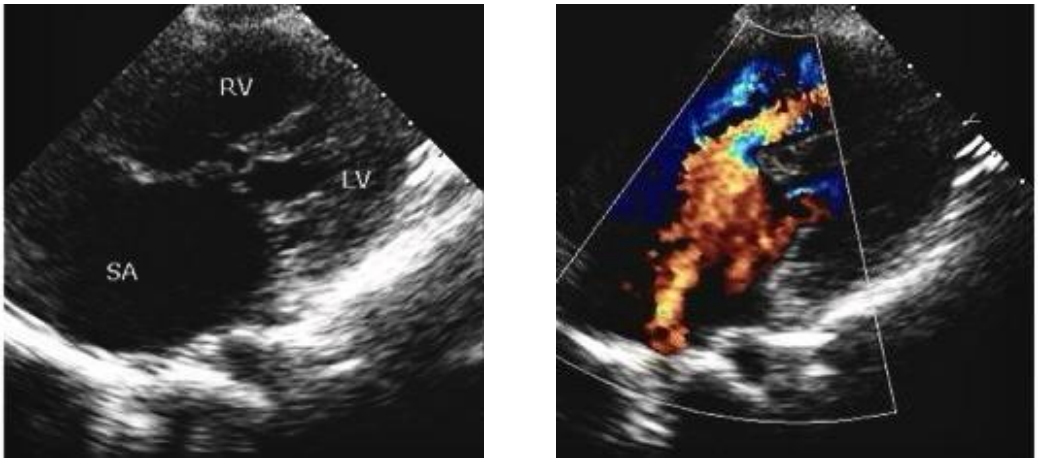


(C) **(D)**

Figure 6: Transthoracic color echocardiography. (A) Echocardiography Doppler showing an ostium primum atrial septal defect with a right-to-left shunt. (B) Echocardiography: apical view with color doppler depicting grade III mitral regurgitation. (C) Subcostal view shows single atrium; (D) Color Doppler imaging depicts left to right shunt across the defect; SA , single atrium; RV, right ventricle; LV, left ventricle.

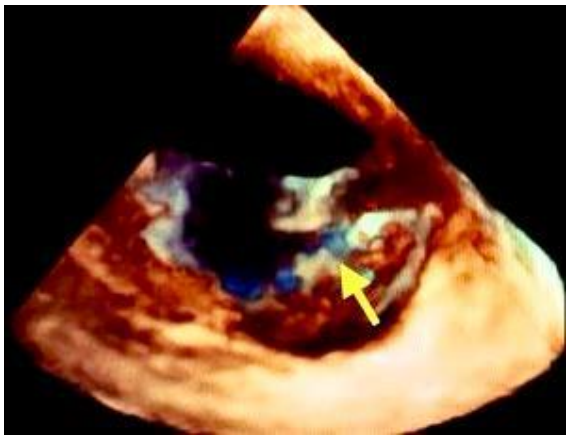
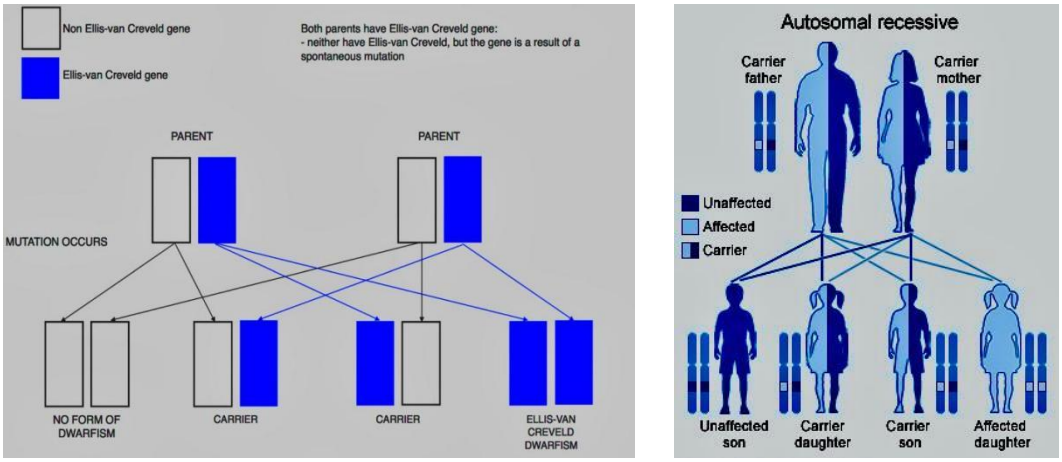


Figure 7: 3-Dimensional echocardiography. Three-dimensioned echocardiogram showing cleft mitral valve.

EVC is a rare genetic abnormality that is autosomal recessive in nature [5] (Figure 8).



(A) **(B)**

Figure 8: Genetics of Ellis-van Creveld Syndrome: Autosomal recessive pattern. (A & B) Diagrammatic illustration of autosomal recessive inheritance.

The EVC gene is located in chromosome 4p16 which is plotted in the short arm of chromosome 4.[6-8] This syndrome is due to the mutation within a non-homologous gene called the EVC2 gene. This EVC2 gene is located close to the EVC gene following a head-to-head configuration[9] (Figure 9).

Gene	Chromosome Location	OMIM	Prevalence
EVC	4p16.2	604831	31–62%
EVC2	4p16.2	607261	21–38%
WDR35	2p24.1	613602	<1%
DYNC2LI1	2p21	617083	~2%
GLI1	12q13.3	165220	<1%
PRKACA	19p13.12	601639	<1%
PRKACB	1p31.1	176892	<1%

Figure 9: EVC disease genes and their prevalence.

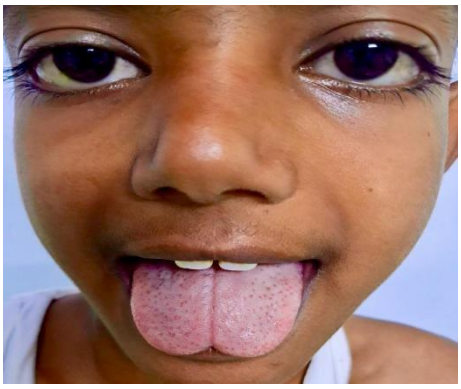
CASE REPORT

A twelve year old adolescent male was referred to us for clinical cardiac evaluation and transthoracic echocardiography (TTE). The history was narrated by the parents who informed that the child was full-term normal delivery born out of consanguineous marriage. There was no history of maternal risk factors of CHD (obesity, diabetes, febrile illness, smoking, alcohol intake, teratogenic drug use, or radiation exposure). The parents apprised us that the child mildly cyanotic since birth. Additionally, they gave history of breathlessness and palpitations when the child used to play associated with recurrent chest infections and failure to thrive. However, they denied any history of loss of consciousness or swelling over feet/face.

On clinical examination, the patient was thin built and alert. Mild cyanosis was identified by bluish colouration of the lips and all the tips of fingers and toes. There were multiple other abnormalities identified in our index patient (Figures 10 A-H)

- Bifid tongue
- Tongue tie
- Dental anomalies
- High arched palate
- Polydactyly of bilateral hands and feet
- Prominent protruding chest wall anomaly with pectus excavatum deformity.
- Bilateral clubbing of fingers and toes

(A)



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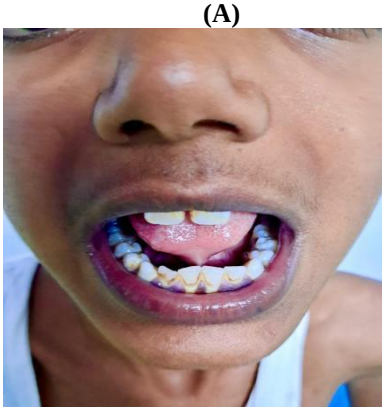

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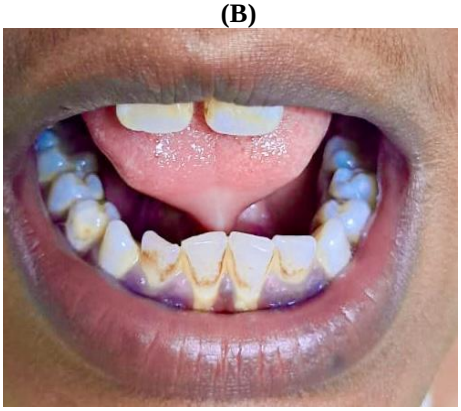

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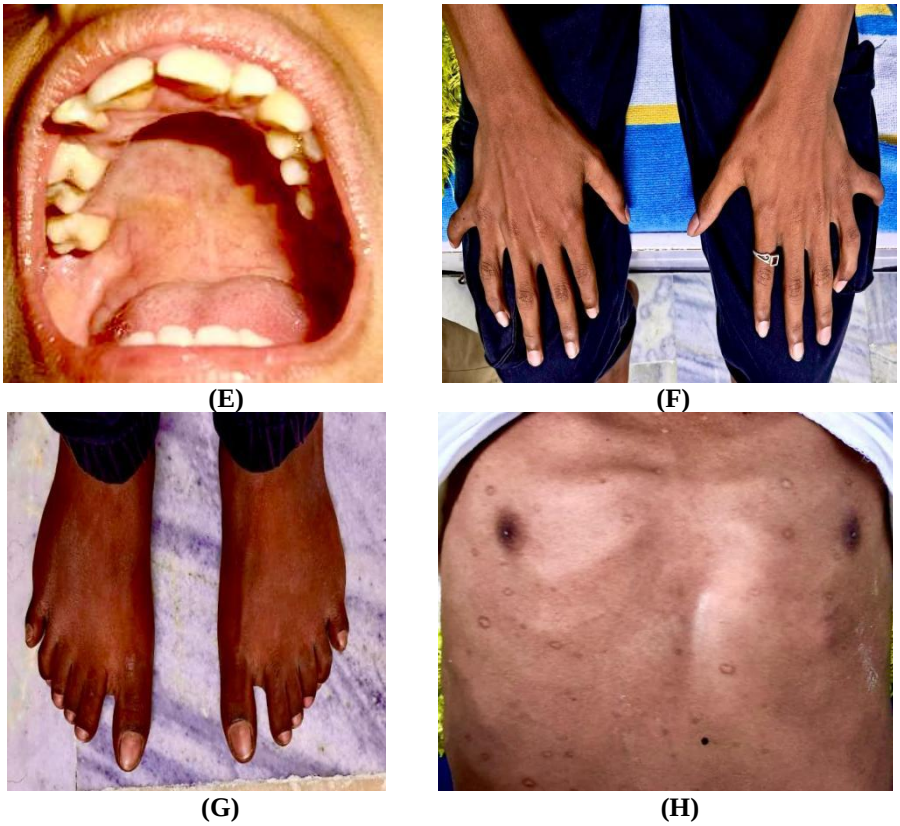


(E) **(F)**

(G) **(H)**

Figure 10: (A) facial appearance. (B) Bifid tongue. (C) Tongue tie. (D) Dental anomalies. (E) High arched palate. (F) Polydactyly of hands. (G) Polydactyly of feet. (H) Protruding chest wall deformity with pectus excavatum.

His weight was 23 kg, height was 56 cm, pulse rate was 93/min, blood pressure was 100/60 mmHg, respiratory rate was 16/min and SPO2 was 93 % at room air. All the peripheral pulses were normally palpable without any radio-femoral delay.

On cardiovascular examination, there was presence of grade 3/6 pansystolic murmur at the lower left sternal border. The first heart sound was normal and second heart sound was closely split and loud. There was no clicks or gallop sound heard. Rest of the systemic examination was unremarkable.

Xray chest PA view (Figure 11) showed cardiomegaly. The cardiac apex was upturned, giving an impression of abnormal cardiac silhouette. Moreover, there was increased pulmonary blood flow.

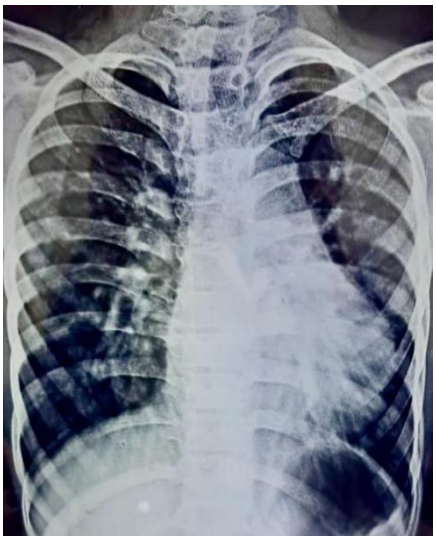


Figure 11: X-ray Chest PA view. There was presence of cardiomegaly. There is upturned cardiac apex alongwith increased pulmonary blood flow.

Resting ECG (Figure 12) revealed normal sinus rhythm with a ventricular rate of 90/min, partial RBBB, extreme left axis deviation, biatrial enlargement and rS complexes from V4-V6 consistent with right ventricular hypertrophy (RVH).

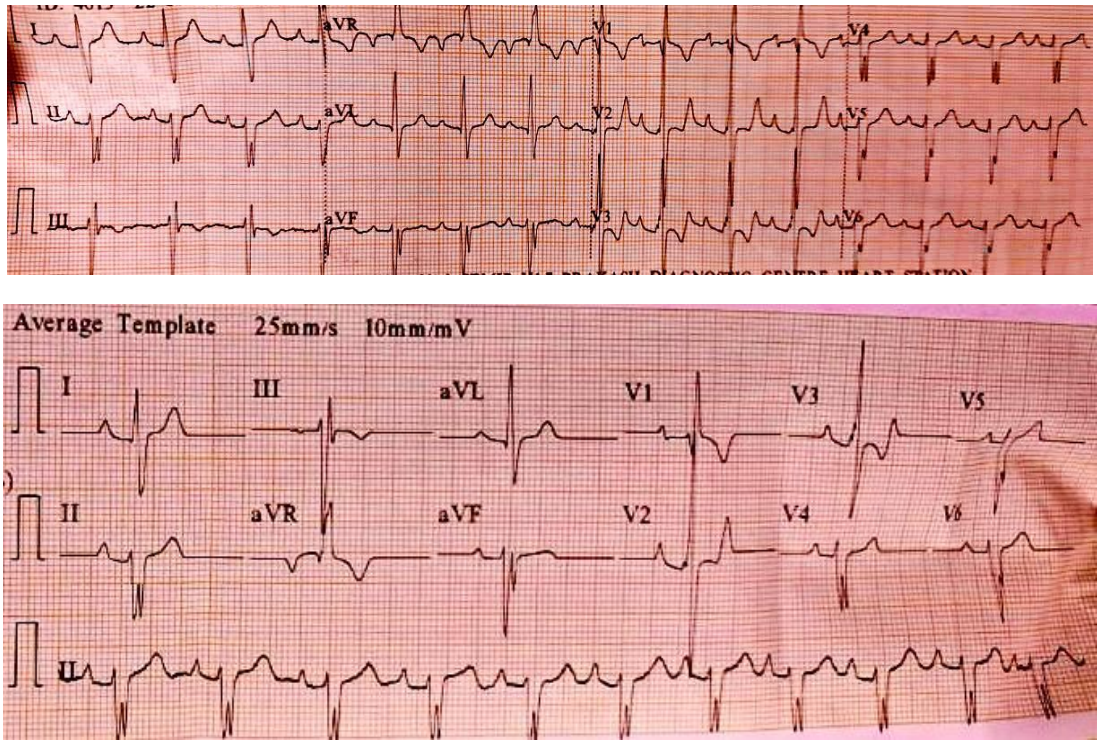


Figure 12: Resting ECG. There is normal sinus rhythm with a ventricular rate 90/ min, partial RBBB, extreme left axis deviation, biatrial enlargement and rS complexes from V4-V6 consistent with right ventricular hypertrophy (RVH).

Transthoracic Echocardiography

All echocardiography evaluations were performed by the author, using My Lab X7 4D XStrain echocardiography machine, Esaote, Italy. The images were acquired using an adult probe equipped with harmonic variable frequency electronic single crystal array transducer while the subject was lying in supine and left lateral decubitus positions.

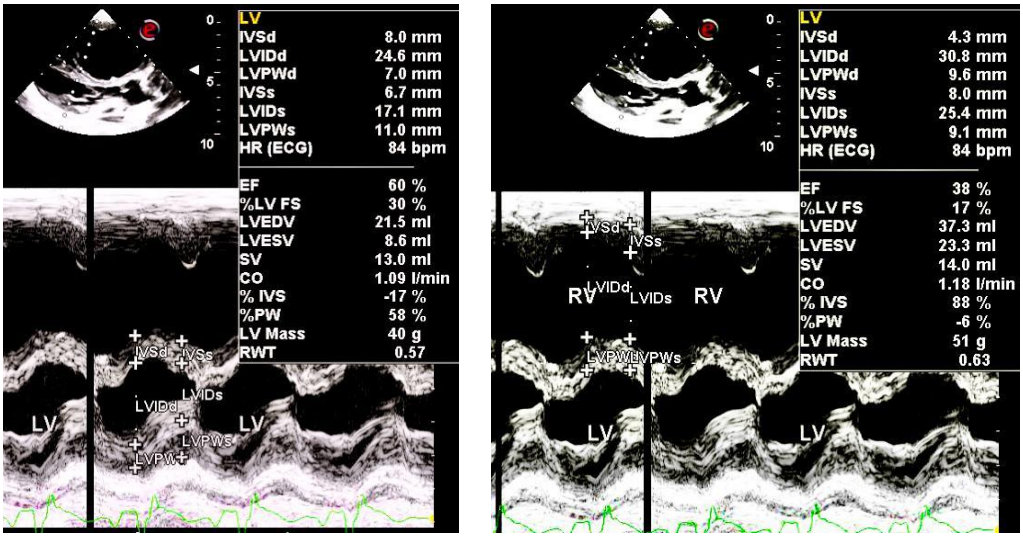
Conventional M-mode, two-dimensional and pulse wave doppler (PWD) and continuous wave doppler (CWD) echocardiography was performed in the classical subcostal, parasternal long axis (LX), parasternal short axis (SX), 4-Chamber (4CH), 5-Chamber (5CH) and suprasternal views. Contemporary sequential segmental approach for echocardiographic analysis of our index patient was accomplished and the characteristic features were depicted.

M-mode Echocardiography

M-mode echocardiography of left and right ventricle was performed and the estimated measurements are outlined (Table 1, Figure 13).

Table 1: Calculations of M-mode echocardiography.

Variables	LV	RV
IVS d	8.0 mm	4.3 mm
LVID d	24.6 mm	30.8 mm
LVPW d	7.0 mm	9.6 mm
IVS s	6.7 mm	8.0 mm
LVID s	17.1 mm	25.4 mm
LVPW s	11.0 mm	9.1 mm
EF	60 %	38 %
%LVFS	30 %	17 %
LVEDV	21.5 ml	37.3 ml
LVESV	8.6 ml	23.3 ml
SV	13.0 ml	14.0 ml
LV Mass	40 g	51 g



(A) **(B)**

Figure 13: M-mode echocardiographic measurements. (A) M-mode measurements of LV; (B) M-mode measurements of RV.

Summary of M-mode echocardiography

The LV was non-dilated with normal systolic function - LVEF 60%. LV mass was 40g. Conversely, RV was dilated with moderately reduced systolic function - RVEF 38%. The RVmass was 51g.

2-Dimensional Color Echocardiography

Transthoracic color echocardiography exhibited multiple features as mentioned below (Figures 14-20):

1. Levocardia

Situs Solitus

D-loop ventricles (non-inverted ventricles)

VA (ventriculo-arterial) concordance

NRGA (normally related great arteries)

Left aortic arch

Confluent pulmonary arteries.

SVC, IVC draining into the right side of common atrium

4 pulmonary veins draining into the left side of common atrium

2. Common Atrium (CA)

There is complete absence of interatrial tissue. On color flow mapping a left to right shunt is present.

Left atrio-ventricular (AV) valve or MV and right AV valve or TV are lying at the same level.

The small inlet VSD is obliterated by the insertion of chordae of septal leaflets of the MV and TV to the crux of ventricular septum (VS).

3. Complete AV septal defect (CAVSD). There is absence of atrioventricular septum causing formation of common atrioventricular junction with TV and mitral valve component. There is Rastelli Type A configuration of CAVSD present. The chordae of TV and MV were attached to the crux of the ventricular septum leading to total obliteration of small inlet VSD.

4. Mitral Regurgitation (Mild)

The MV were thickened.

A cleft is present on the septal (anterior leaflet) of the mitral valve.

On color flow mapping MR jet area was 2.06 sqcm with a central jet.

5. Tricuspid Regurgitation (Severe)

Anterior leaflet of TV is large, thickened and sail like, and the small septal leaflet of TV is attached to the crux of the ventricular septum.

TR jet velocity = 3.55 m/sec (gradient 50 mmHg)

On color flow mapping TR jet area 11.16 sqcm; occupying 50 % of RA area, with an eccentric anterior jet.

6. Dilated Pulmonary arteries

PV annulus (D): 18.4 mm, AV annulus (D): 11.3 mm, MPA (D): 16.6 mm, LPA (D): 10.4 mm, RPA (D): 6.8 mm.

7. Dilated RV with concentric hypertrophy

Moderately reduced RV systolic function, RVEF = 38 %

Small LV cavity

Normal LVEF = 60 %

8. Severe PAH (estimated RVSP/PAP = 60 mmHg)

9. No evidence of VSD, PDA, COA, AS, PS.

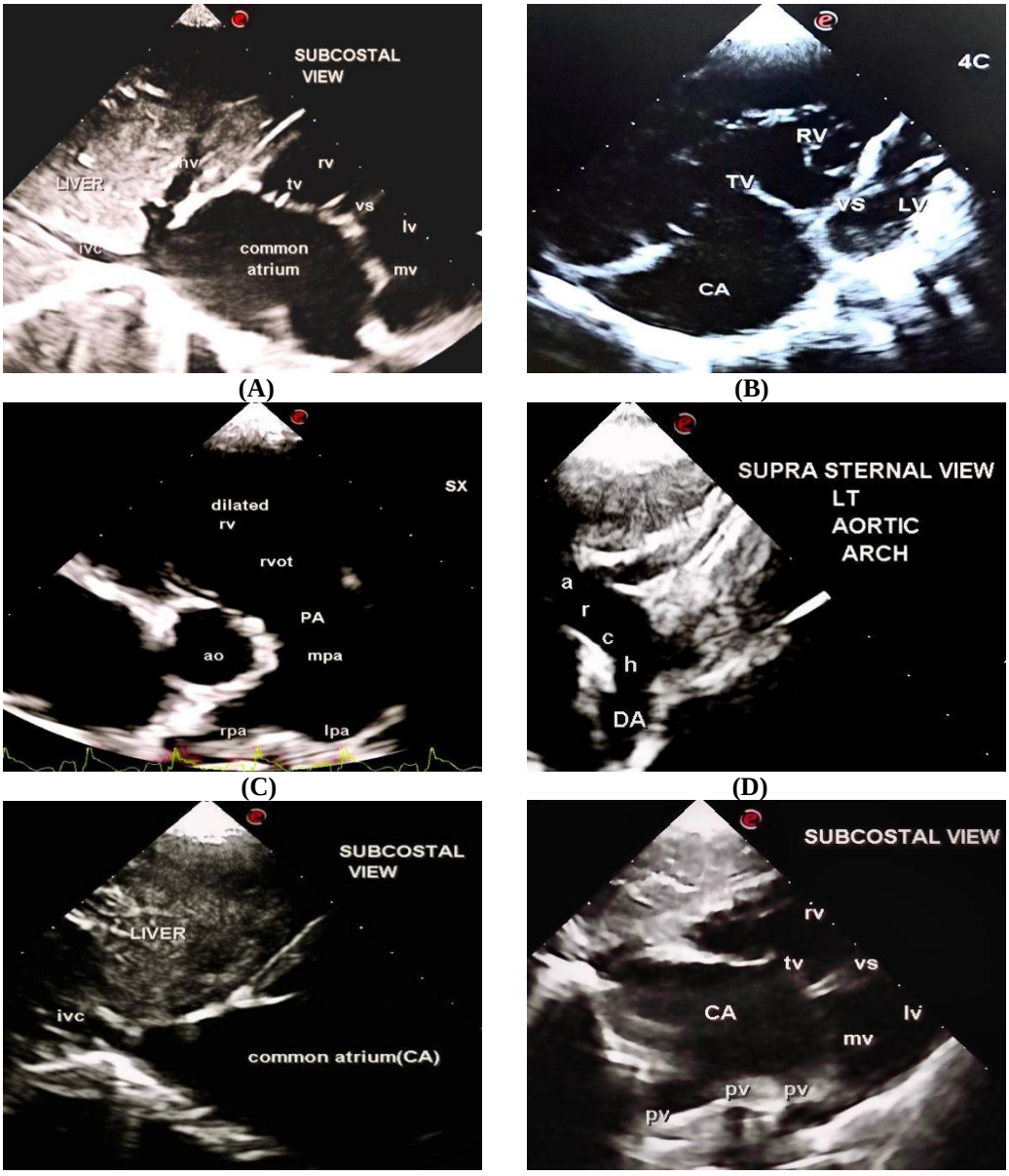


Figure 14: (A) Situs solitus: right sided liver, ivc opening into the right side of common atrium (CA); (B) D-loop ventricles : RV lying on the right side of LV; (C) Normally related great arteries; (D) Left aortic arch; (E) IVC draining into right side of CA; (F) Pulmonary veins draining into left side of CA; rvot, right ventricular outflow tract; CA/SA, common atrium; ivc, inferior vena cava; hv, hepatic vein; pv, pulmonary vein.

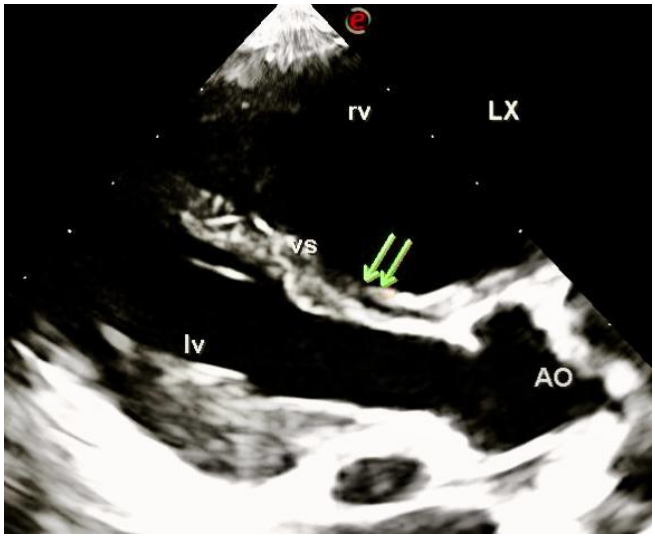
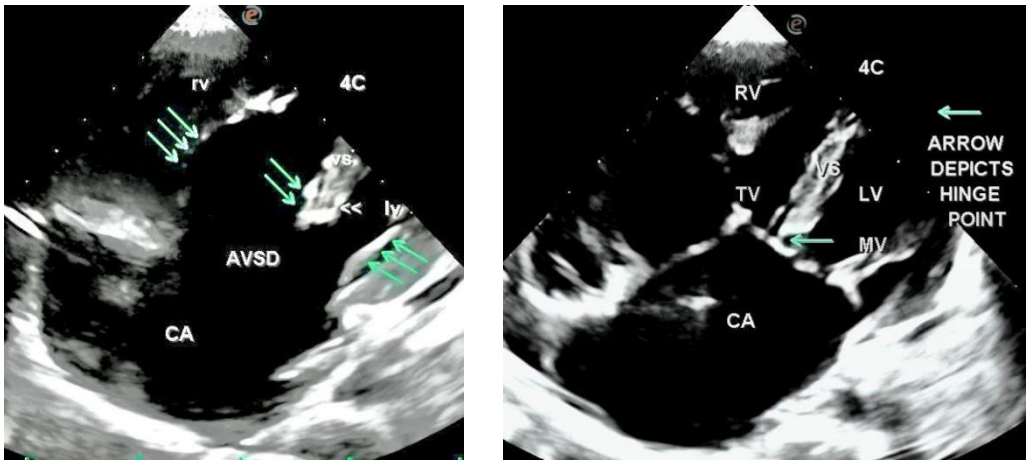
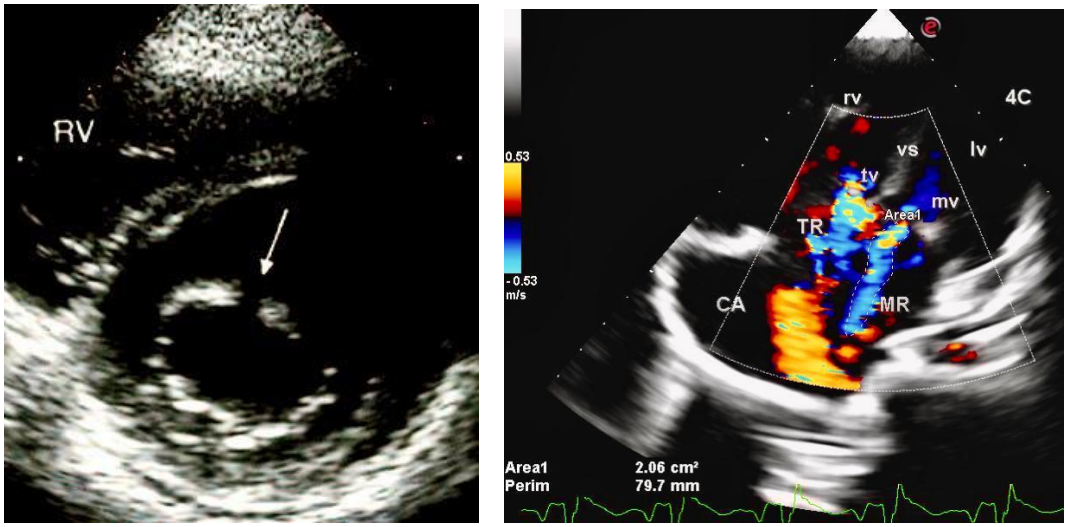


Figure 15: LX view shows elongated left ventricular outflow tract (LVOT) producing a goose neck deformity . Green arrows denote goose neck deformity of LVOT.



(A) **(B)**

Figure 16: Common atrium. 4C View (A) Diastolic frame: There is complete absence of interatrial septum. The anterior leaflet of TV was large, thickened and sail like (depicted by 3 green arrows). The septal leaflet of TV (denoted by 2 green arrows) was adhering to the ventricular septum (vs) crux. Similarly the septal leaflet of the MV was attaching to the vs crux (indicated by <<) and the posterior leaflet of MV was large and thickened (depicted by 3 green arrows). Complete Atrioventricular septal (AVSD) of Rasteilli A type was demonstrated. The common AV valve with tricuspid and mitral components were attached to the crux of the ventricular septum, as described above; (B) Systolic frame: The TV and MV orifices were concordantly connected to the dilated RV and the non dilated LV, respectively. The septal leaflets were seen anchoring to ventricular septal crux at a hinge point (single green arrow), where the chordae of the septal leaflets were inserting . The small inlet VSD was totally obliterated by the chordae of common AV valve leaflets. Therefore, no VSD was discerned; AVSD, atrioventricular septal defect; CA, common atrium.



(A) **(B)**

Figure 17: (A) Cleft of anterior mitral leaflet was visualised causing; (B) mild mitral regurgitation (MR). The MR jet area was 2.06 sq cm with a central jet.

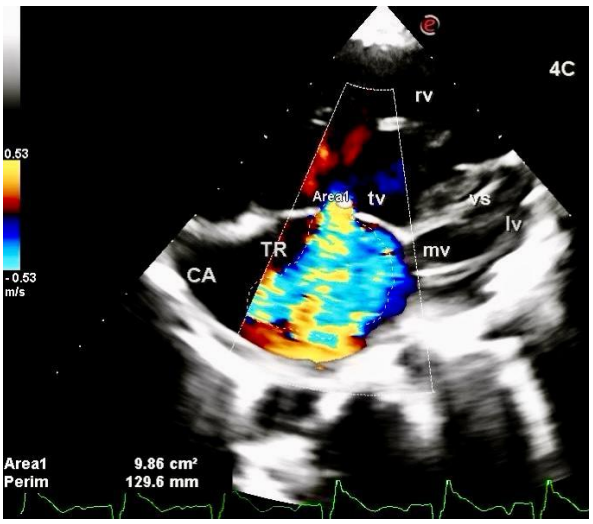


Figure 18: 4C view demonstrates severe TR jet. On color flow mapping (CFM) the TR jet area was 9.86 sqcm, occupying nearly 50 % of common atrium area.

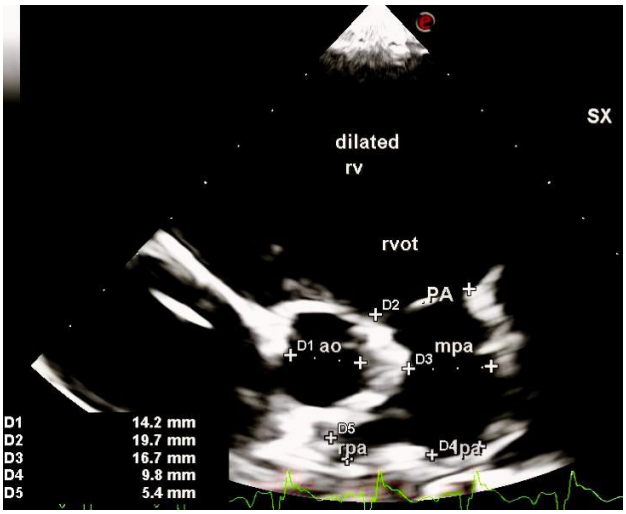


Figure 19: Dilated pulmonary arteries. The pulmonary valve annulus, main pulmonary artery (mpa), left pulmonary artery (lpa) and right pulmonary artery (rpa) are dilated; ao, aorta; rvot, right ventricular outflow tract; rv, right ventricle; PA, pulmonary artery.

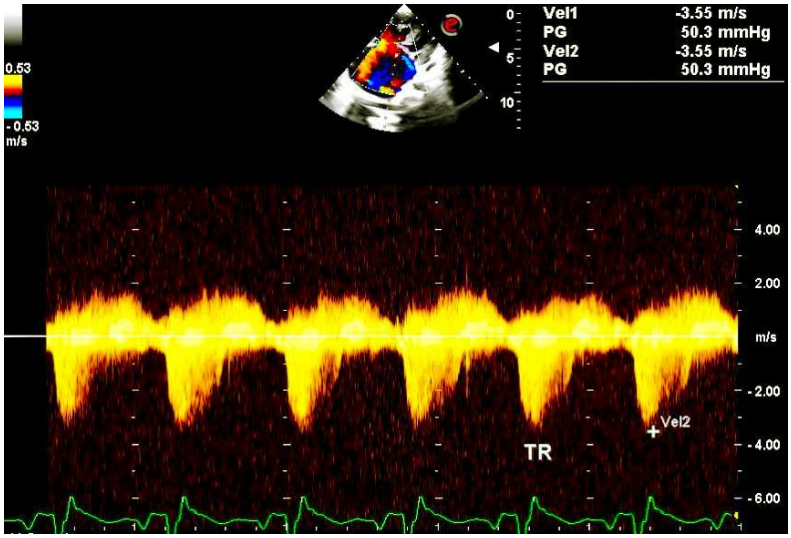


Figure 20: Severe pulmonary hypertension. On continuous wave doppler (CWD) analysis across the TV, a CWD signal of TR is depicted with a peak velocity of 3.55 m/sec and a peak gradient of 50 mmHg. The estimated right ventricular systolic pressure (RVSP)/pulmonary artery pressure (PAP) was 60 mmHg.

Summary of 2-Dimensional color echocardiographic features

Our index patient was afflicted with multiple cyanotic congenital heart defects: common atrium, AVSD, cleft anterior mitral leaflet causing mild mitral regurgitation, severe TR, pulmonary hypertension, dilated RV with moderately reduced RV systolic function-RVEF 38 % and small LV cavity with a normal systolic function-LVEF 68 %.

Future course of action

In view of widespread involvement of multiple systems, a comprehensive multidisciplinary approach for management was advocated. Hence, our patient was referred to a tertiary care pediatric cardiovascular institute for suitable palliative/corrective surgery for his cardiac defects and for the management of his other orthopedic and dental anomalies.

DISCUSSION

Richard W.B. Ellis of Edinburgh and Simon van Creveld of Amsterdam named a clinical case with a pathology of chondroectodermal dysplasia as Ellis van Creveld Syndrome in the late 1930s. It is an autosomal recessive syndrome with disproportionate dwarfism, postaxial polydactyly, ectodermal dysplasia, a small chest, and a high frequency of congenital heart defects . Other features include partial harelip and multiple frenulae in the lips; short ribs and narrow chest; genital abnormalities like epispadias, hypospadias and cryptorchidism; low iliac wings with spur-like projections at acetabula and genu valgum.[10] Although most patients have normal intelligence, occasional central nervous system anomalies or mental retardation has been reported. It is commonly seen in the Amish population of Pennsylvania in USA but also occur in non Amish population with the prevalence around 7/1,000,000 live births.[11]

Cardiac manifestation are seen in 50-60% of cases. Common atrium (CA) is an uncommon cardiac malformation, and yet it is commonly found in patients with EVC.[12] In a series of Mekusick et al[13], complete atrioventricular canal defect was the most common congenital abnormality seen in 40% of cases followed by partial atrioventricular canal defect, a ventricular septal defect or a patent ductus arteriosus.

50% patients with Ellis Van Creveld syndrome usually die in infancy due to recurrent respiratory infections. Those without any cardiac abnormality may have a normal life expectancy. The patient having a complete atrioventricular canal defect with EVC has survived till 19 years without any significant pulmonary artery hypertension.[14]

Atrioventricular septal (atrio-ventricular canal defect)

Atrioventricular septal defects are a group of malformations involving the atrioventricular (AV) septum and common atrioventricular junction (Figure 21).

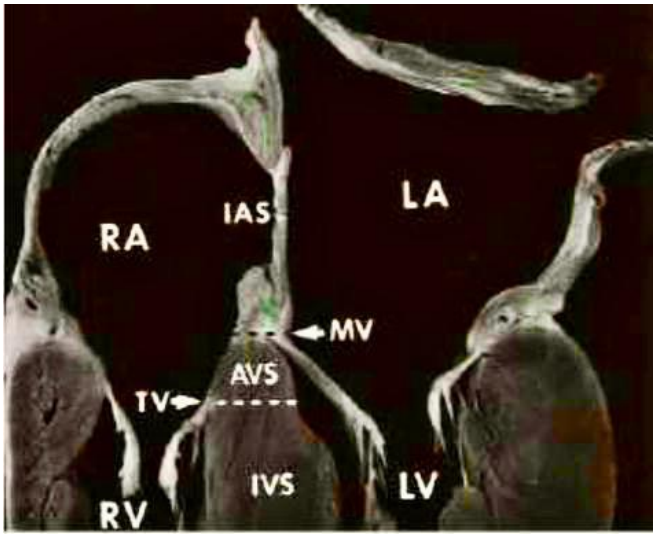


Figure 21: Atrioventricular septum in the normal heart. The atrioventricular septum (AVS) lies between the right atrium (RA) and the left ventricle (LV). LA, left atrium; RV, right ventricle; MV, mitral valve; TV, tricuspid valve.

Previously, referred to as atrioventricular canal (AVCD) or endocardial cushion defects, is now called AV septal defect (AVSD). They are divided into complete, partial and variations of both of them based on the orifices and septal communications which will be discussed in detail in this chapter.

Around half of the patients with AVSD have Down syndrome. However, approximately 45% of CHD patients with Down syndrome have AVSD.[15, 16] Most of these cases are isolated, although some may have pulmonary stenosis or atresia. There is an association with other anomalies like heterotaxy and Ellis-Van Creveld syndrome.[17]

Pathology

In a normal heart, tricuspid and mitral valve annuli are positioned at different levels because of the atrioventricular septum. In AV septal defects, tricuspid valve annulus is located more apically in relation to mitral valve. The portion of the offset between tricuspid and mitral valve is the location of atrioventricular septum. It has overlapping atrial and ventricular walls.[18] Aortic valve is located anterior and superior between tricuspid and mitral valve, what is referred to as wedged between these valves. This makes the subaortic outflow region placed in between tricuspid and mitral valves. The papillary muscles in the left ventricle are located antero-superior and postero-inferior region. Another feature of importance is the distance from mitral valve to apex of left ventricle is same as the distance from left ventricular apex to aortic valve (Figure 22).

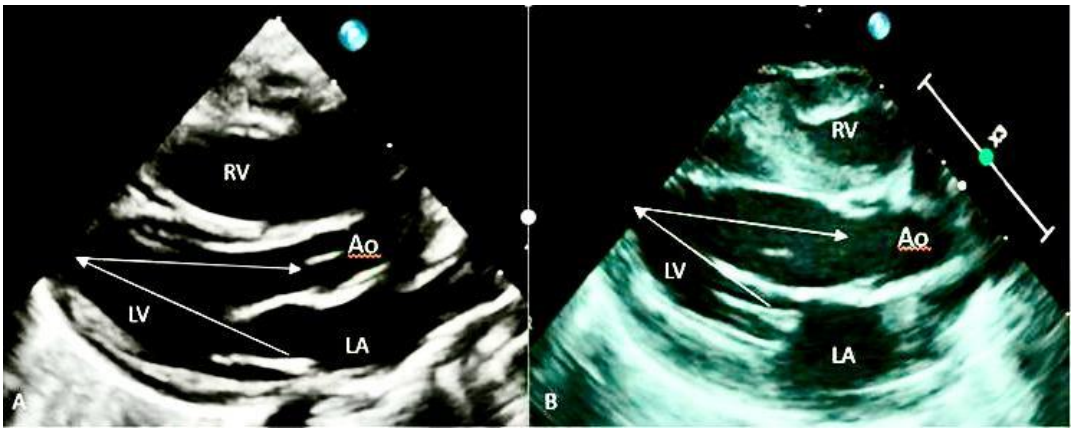


Figure 22: 2D echocardiogram parasternal long axis view: A. In normal cardiac anatomy, distance from the mitral valve to left ventricular (LV) apex and from LV apex to aortic valve is same. B. In AVSD, LVOT is elongated and distance from LV apex to left AV valve annulus is shorter. LA, left atrium; RV, right ventricle; Ao, aorta.

In patients with AV septal defect, the fundamental abnormality is absence of the atrioventricular septum or having a common atrioventricular junction. This results in a cascade of features that are different from normal hearts. The common features shared by all forms of atrioventricular septal defects are:

a. Presence of common atrioventricular valve
b. Elongation of the left ventricular outflow tract
c. Clockwise rotation of papillary muscles
d. Cleft in the left AV valve

Classification

There are two major types of AV septal defects: complete and partial AVSDs. Two sub-types are described: intermediate and transitional, which are variations of complete and partial AV septal defects, respectively (Figure 23).

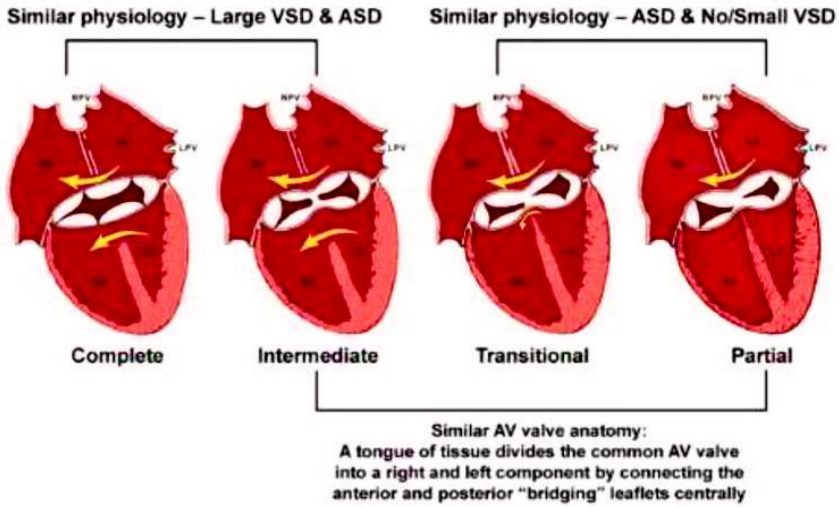


Figure 23: Summary of AVSD. Anatomic and physiologic similarities between the different forms of atrioventricular septal defect (AVSD) are illustrated. Complete AVSDs have one orifice with large interatrial and interventricular communications. Intermediate defects (two orifices) are a subtype of complete AVSD. Complete AVSDs have physiology of VSDs and atrial septal defects (ASDs). In contrast, partial AVSDs have physiology of ASDs. Transitional defects are a form of partial AVSD in which a small inlet VSD is present or the ventricular level shunt has been obliterated by chordal tissue. Partial AVSDs and the intermediate form of complete AVSD share a similar anatomic feature: A tongue of tissue divides the common atrioventricular valve into distinct right and left orifices. LA, left atrium; LPV, left pulmonary vein; LV, left ventricle; RA, right atrium; RPV, right pulmonary vein: RV. right ventricle.

Different combinations of shunting across atria and ventricles could happen based on the attachments and relationship of the bridging leaflets to septal structures. In general, we would see ostium primum defect and ventricular septal defect (VSD). If the bridging leaflets are attached to the atrial septum, there could be only a ventricular level shunt (Figure 24).

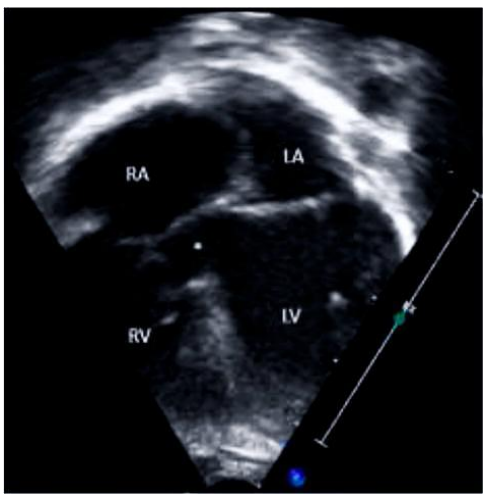


Figure 24: 2D echocardiogram apical four-chamber view: A rare form of AVSD with large inlet ventricular septal defect (*) without a primum atrial septal defect. Note that AV valves are at same level. RA, right atrium; RV, right ventricle; LA, left atrium; LV, left ventricle.

When the bridging leaflets are attached to the crest of ventricular septum, it results in an atrial level shunt with an ostium primum defect. In rare instances, where the bridging leaflets close the septal defect(s), we will still see features of the common atrioventricular valve.[19-21] Complete AVSDs are classified further into three types based on the morphology of anterior bridging leaflet and is named after Giancarlo Rastelli, who made significant contributions in his short career and life span:

1. Type A: In this type, anterior bridging leaflet (ABL) is divided and attached to the crest of the interventricular septum. It is the most common defect and is associated with Down syndrome.
2. Type B: ABL is partly divided and is not attached to the crest of the septum. Chordae attach usually to papillary muscle in the right ventricle (RV), on the septal surface. It is the least common of all types.
3. Type C: ABL is not attached or divided and is termed "free-floating". There are chordal attachments to RV free wall. This type is seen in Down syndrome patients with Tetralogy of Fallot; double outlet right ventricle, complete transposition of the great arteries, and heterotaxy syndromes.

Pathophysiology

In patients with complete AVSD, there is one common AV valve with large atrial and inlet VSD (Figure 25).

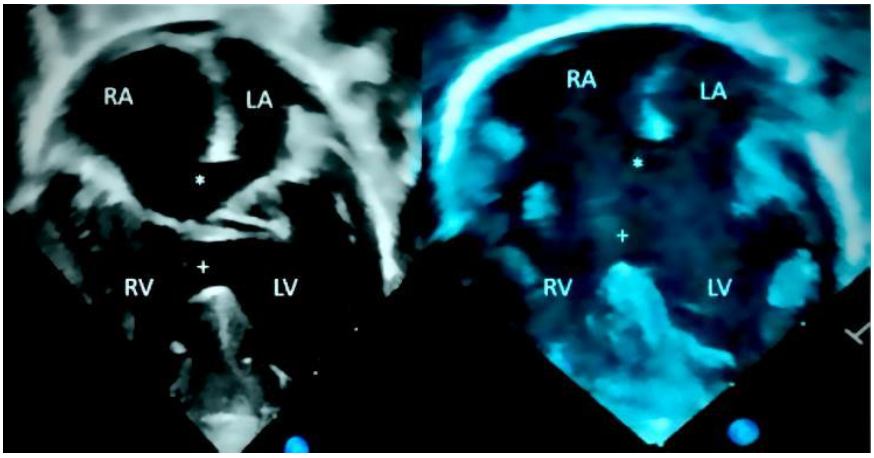


Figure 25: 2D echocardiogram apical 4-chamber view: Complete balanced AVSD. A. When AV valve is closed, there is large primum atrial septal defect (ASD, *) and large inlet ventricular septal defect (VSD, +). Common AV valve and single orifice. B. with valve open. RA, right atrium; LA, left atrium; RV, right ventricle; LV, left ventricle.

In intermediate form, there are two AV valve orifices, which are formed by a tongue of tissue between superior and inferior bridging leaflets. It has similar physiology as the complete form with large ASD and VSD. In partial AV septal defects, where there are two AV valve orifices with the bridging leaflet attached to ventricular septal crest, giving rise to only interatrial communication (Figure 26A).

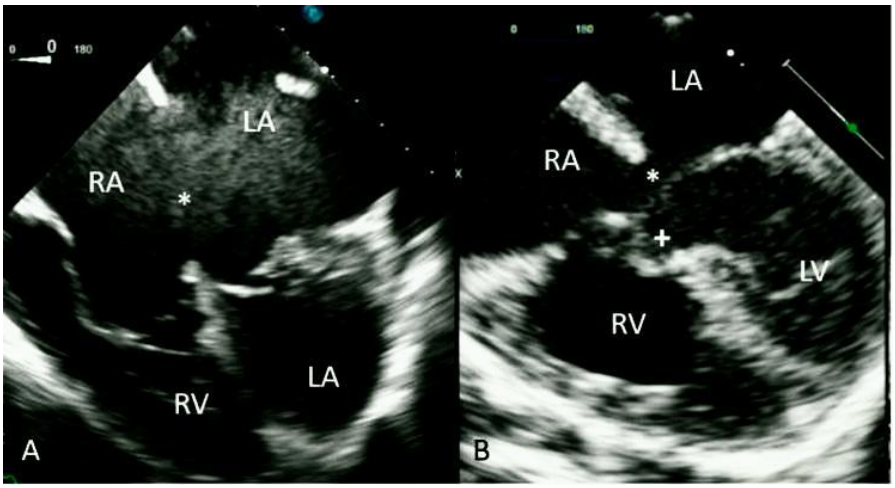


Figure 26A: (A) Transesophageal echocardiogram, four-chamber view. A. Partial AVSD with large primum atrial septal defect (ASD) (*). Note the valvar attachments to crest of the septum. (B) Transitional AVSD with small primum ASD and inlet ventricular septal defect (+) covered by right AVV chordal attachments to the crest of ventricular septum. RA, right atrium; LA, left atrium; RV, right ventricle; LV, left ventricle.

In some instances, there could be communication at the ventricular level from the chordal attachments, which is described as a transitional type (Figure 26B).

In all forms of AV septal defects, the left AV valve invariably has a cleft. Rarely there will be no septal communications seen with other common features of AVSD.[19]

Prognosis

Although there is no systematic follow-up EVC series reported, the prognosis is linked to the respiratory difficulties in the first months of life and these difficulties are related to thoracic narrowness and possible heart defect.[2] The syndrome is characterized by high mortality in early life, with 50% of deaths occurring during infancy.[2]

The life expectancy is mainly determined by the congenital heart defect and the respiratory problems due to thoracic cage deformity.[22] Patients who survive infancy have a normal life expectancy, the oldest living patient was 82 years of age.[23]

The cognitive development in EVC syndrome is normal. Prognosis of the final body height in individual patients with EVC is difficult to predict, as the rare publications of adult EVC cases report a variable final stature, from 119 cm[24] to 161 cm.[25]

CONCLUSION

In EVC syndrome 50% of the patients die in infancy due to cardiac anomalies and thoracic dysplasia leading to respiratory insufficiency. It is necessary to identify this syndrome at its early stage in order to refer the case to a paediatric cardiologist, cardiac and thoracic surgeon, dentist and orthopaedic surgeon for corrective surgeries.

REFERENCES

1. Digilio, MC, Marino B, Ammirati A, Borzaga U, Giannotti A and Dallapiccola B. Cardiac Malformations in Patients with Oral-Facial-Skeletal Syndromes: Clinical Similarities with Heterotaxia. American Journal of Medical Genetics, 1999; 84: 350-356.
2. Paiva LV, Providencia R, Sá J, Bastiaenen R, Botelho A, Mota P, Leitao-Marques A. Corrected ASD: case closed? BMJ Case Rep. 2011:bcr0120113714.
3. Munoz-Armas S, Gorrin JR, Anselmi G, Hernandez PB and Anselmi A. Single Atrium. Embryologic, Anatomic, Electrocardiographic and Other Diagnostic Features. American Journal of Cardiology, 1968; 21: 639-652.
4. Rastelli GC, Rahimtoola SH, Ongley PA and McGoon DC. Common Atrium: Anatomy, Hemodynamics, and Surgery. Journal of Thoracic and Cardiovascular Surgery, 1968; 55: 834-841.
5. Ruiz-Perez VL, Ide SE, Strom TM, Lorenz B, Wilson D, Woods K, King L, Francomano C, Freisinger P, Spranger S, Marino B, Dallapiccola B, Wright M, Meitinger T, Polymeropoulos MH, Goodship J. Mutations in a new gene in Ellis-van Creveld syndrome and Wevers acrodental dysostosis. Nat Genet, 2000; 24: 283-6.
6. Ellis-van Creveld Syndrome: a report of two cases. Arya L, Mendiratta V, Sharma RC, Solanki RS. Pediatr Dermatol., 2001; 18: 485–489.
7. Sequencing EVC and EVC2 identifies mutations in two-thirds of Ellis-van Creveld syndrome patients. Tompson SW, Ruiz-Perez VL, Blair HJ, et al. Hum Genet., 2007; 120: 663–670.
8. Ellis-van Creveld syndrome. Baujat G, Le Merrer M. Orphanet J Rare Dis., 2007; 2: 27.
9. Ellis van Creveld syndome. Ghanekar J, Sangrampurkar S, Hulinaykar R, Ahmer T. J Assoc Physicians India, 2009; 57: 532–534.
10. Phatak SV, Kolwadkar PK, Phatak MS. Ellis van Creveld syndrome: Report of two cases. Indian J Radiol Imaging, 2003; 13: 393-4.
11. Natal teeth. Medline Plus: U.S. National Library of Medicine 2013.
12. Baujat G, Le Merrer M. Ellis van C reveld syndrome: Review. Orphanet Journal of Rare Dis 2007; 2: 27: 1-5.
13. McKusick VA, Egeland JA, Eldridge R, Krusen DE. Dwarfism in the Amish I. The Ellis–van Creveld syndrome. Bulletin of the Johns Hopkins Hospital, 1964; 115: 306-36.
14. Toshifumi M, Takehiro K, Jun-ichi O et al. Left atrioventricular valve regurgitation after repair of incomplete atrioventricular septal defect' Ann Thoac Surg., 2004; 77: 2157-2162.
15. Stoll C, Dott B, Alembik Y, Roth M-P. Associated congenital anomalies among cases with down syndrome. European Journal of Medical Genetics, 2015; 58: 674-680.
16. Mourato FA, Villachan LRR, Mattos S da S. "Prevalence and profile of congenital heart disease and pulmonary hypertension in down syndrome in a pediatric cardiology service." Revista Paulista de Pediatria, 2014; 32: 159-163.
17. Cetta HMF, Truong F, Minich D, Maleszewski LL, O'Leary JJ, Dearani PW, et al. Atrioventricular Septal Defects. In: Ninth FCHD, Allen RE, Shaddy DJ, Feltes PTF, editors. Moss and Adams & Apos; Heart Disease in Infants, Children, and Adolescents: Including the Fetus and Young Adult. Philadelphia: Lippincott Williams & Wilkins, 2016; 757-782.
18. Tjark Ebels RHA, Tretter JT, Spicer DE. Atrioventricular septal defects. In: Fourth G, Wernovsky A, editors. Anderson's Pediatric Cardiology. Philadelphia: Elsevier Inc., 2019; 521-554.
19. Silverman NH, Ho SY, Anderson RH, Smith A, Wilkinson JL. Atrioventricular septal defect with intact atrial and ventricular septal structures. International Journal of Cardiology, 1984; 5: 567-573.

20. Ho SY, Russell G, Gerlis LM. Atrioventricular septal defect with intact septal structures in a 74-year old. International Journal of Cardiology, 1990; 26: 371-373.
21. Kaski JP, Wolfenden J, Josen M, Daubeney PEF, Shinebourne EA. Can atrioventricular septal defects exist with intact septal structures? Heart, 2006; 92: 832-835.
22. Singh S, Arya V, Daniel MJ, Vasudevan V. Ellis-van Creveld Syndrome: A Case Report. Int J Clin Pediatr Dent., 2012; 5: 72-4.
23. Gorlin RJ, Cohen MM, Hennekam RCM. Syndromes affecting bone. Chondrodysplasias and chondrodystrophies. Syndromes of the head and neck. Oxford University Press., 2001; 4: 239–42.
24. Renier JC, Larget-Piet L, Boasson M, Berthelot J, Fouillet L: Dysplasie chondroépidermique d'Ellis-van Creveld: deux cas dans une même fratrie. Revue du rhumatisme, 1975; 42: 417-422.
25. Oliveira da Siva E, Janovitz D, Cavalcantide Albuquerque S: Ellis-van Creveld syndrome: report of 15 cases in an inbred kindred. J Med Genet., 1980; 17: 349-356.