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Radial ray anomaly with associated ventricular septal defect – case report with review of literature

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radial ray; anomaly; aneuploidy; genetic syndrome

Abstract

Ultrasound examination is used for the assessment of abnormal findings on prenatal screening. Radial ray defect can be screened by using ultrasonography. Abnormal findings can be detected quickly by having the understanding of the etiology, pathophysiology and embryology. It is a rare congenital defect that may be isolated or associated with other anomalies including Fanconi's syndrome and Holt-Oram syndrome. We report the case of a 28-year-old woman (G2P1L1) who presented for routine antenatal ultrasound at 25 weeks 0 days according to the last menstrual period. The patient did not have any level-II antenatal anomaly scan done. An ultrasound was performed, and the gestational age according to the ultrasound scan was 24 weeks and 3 days. In this paper, we present a brief review of embryology and critical practical points, and report a rare case of radial ray syndrome with associated ventricular septal defect.

Introduction

Ultrasound evaluation of a fetus with radial ray defect is a difficult diagnostic dilemma. Radial aplasia or hypoplasia is a rare abnormality occurring in 2:10,000 live births. Among the genetic causes, one of the more common disorders associated with radial ray anomalies is Holt-Oram syndrome occurring in 1:1,00,000 live births and characterized by forelimb deformities, congenital heart disease, and/or cardiac conduction abnormalities.

The condition encompasses partial or complete absence of the radius and/or radial ray structures. Isolated cases are associated with various anomalies. Subtle abnormalities can be better appreciated using detailed ultrasonography, including 2-D or 3-D imaging. Prenatal ultrasound screening is also employed for detecting congenital malformations and structural heart defects. Previous studies have also identified the prevalence of ventricular septal defect (VSD) at 10 to 16% in fetal tests. Chromosomal anomalies associated with VSD include trisomies 21, 13, and 18, deletion in 22q11, and non-chromosomal malformed fetuses. The aim of this study was to report the case of a patient with radial ray anomaly with ventricular septal defect that presented in our institute.

Case presentation

A 28 year-old woman of Indian origin, G2P1L1, presented to an obstetrical outpatient clinic for routine antenatal check-up. The patient's gestational history was unremarkable, with no significant past medical or surgical events. There was no significant history of drug intake. Her menstrual cycles were regular. The patient did not have any level-II antenatal anomaly scan done. Her gestational age according to the last menstrual period was 25 weeks 0 days. She was referred to our department for antenatal scan. Gray-scale ultrasound revealed the mean gestational age to be 24 weeks 3 days. The fetus had absence of both radii, a short forearm, bowing of the ulna, and associated ventricular septal defect.

A transabdominal ultrasound scan showed a short forearm. The ulna was seen, shortened with associated bowing. The radius was absent in both forearms. As a result of above findings, the appearance of the club hand was visualized (Fig. 1). 3D ultrasound of the fetal upper limb showed a short forearm with associated bowing, as seen in Fig. 2. The finding of the club hand shown on 2D ultrasound was subsequently confirmed on 3D ultrasound. Based on these findings, a working diagnosis of bilateral radial ray was made.

Fetal heart examination was performed starting from a four-chamber view, using real-time scanning, and color Doppler was used to detect the presence of VSD during the phase of shunt between the right and left ventricles (Fig. 3). The heart was also examined using a lateral view allowing the drop-out effect due to the insonation angle by the four-chamber view. It also enabled the flow crossing the septum, indicating a septal defect, to be detected accurately (Fig. 4).

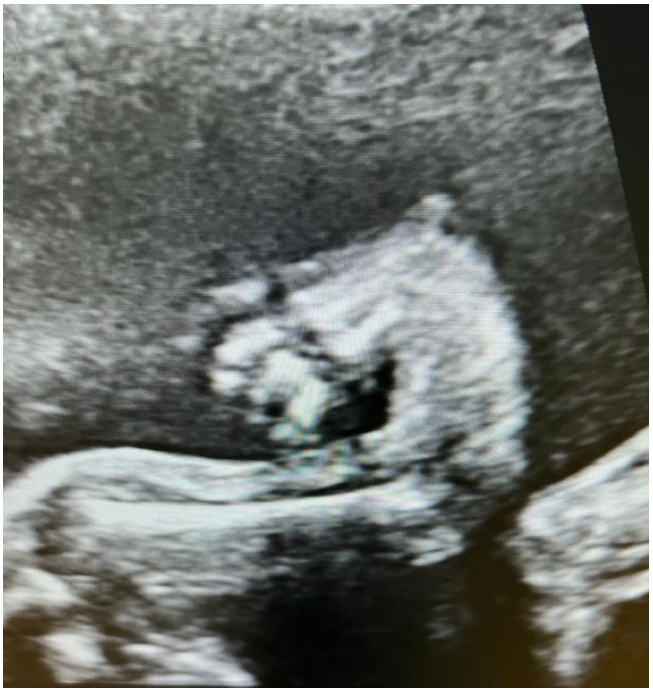

Fig. 1. *Transabdominal ultrasound image showing short forearm with absence of the radius bone. The ulna is shortened with associated bowing, giving the appearance of club hand*

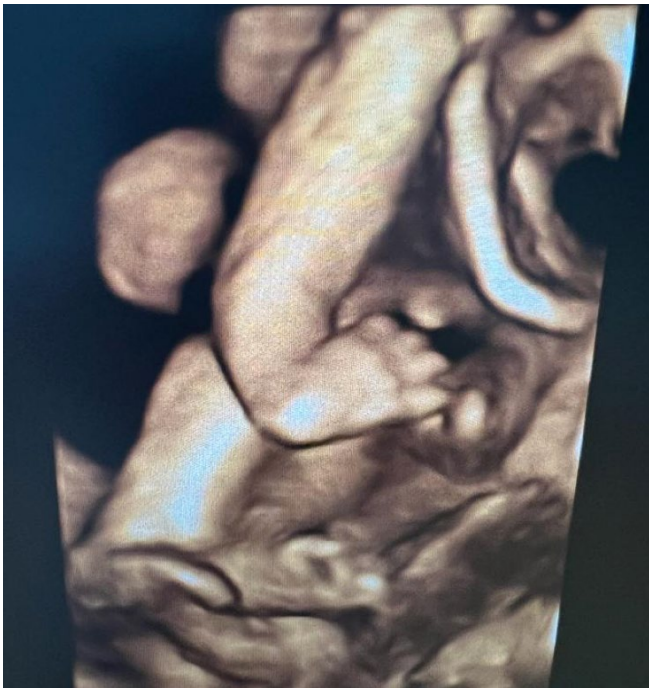

Fig. 2. *3D ultrasound of the fetal upper limb showing short forearm with associated bowing*

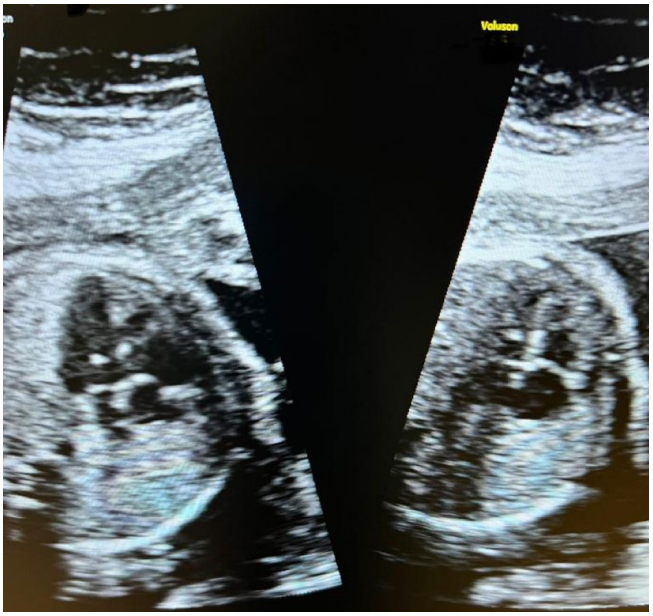

Fig. 3. *Transabdominal ultrasound through fetal heart in four-chamber view showing ventricular septal defect (VSD)*

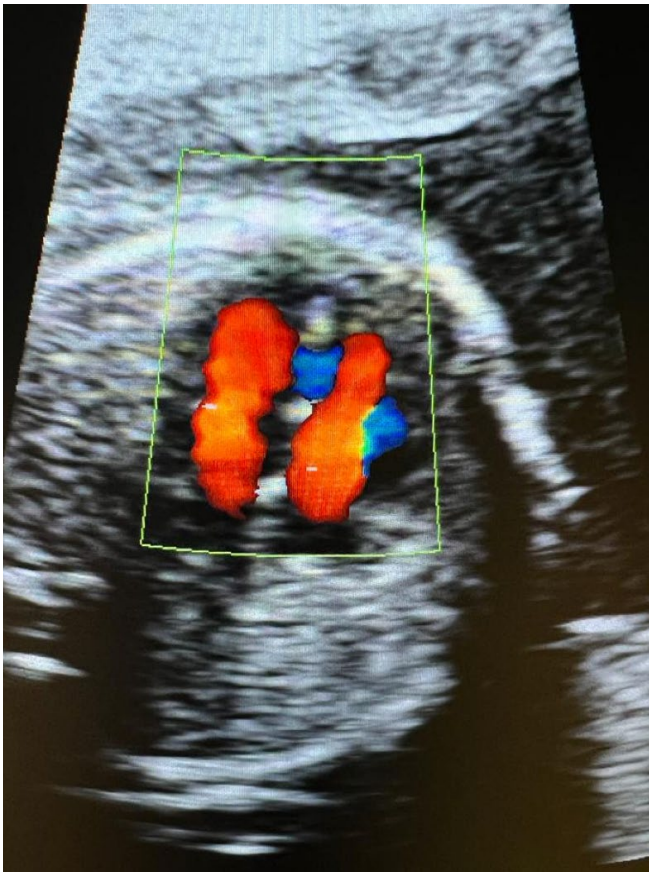

Fig. 4. *Transabdominal ultrasound with color Doppler through fetal heart in four-chamber view confirms the finding of VSD showing the flow of blood from one ventricle to other (shown in blue)*

Although it was a post level II scan, despite our best efforts and thorough examination of the fetus, no other associated abnormality was detected other than these two.

Detailed family history of showed that no other family member was affected by this or similar malformations. The findings of the scan were not presented to the patient as such. Instead, a report was dispatched to the patient and she was requested to meet the attend-

ing doctor. The case was discussed with the gynecologist and fetal echocardiography was suggested. The patient underwent fetal echocardiography and the findings confirmed ventricular septal defect.

After adequate support and consultations with a clinical geneticist and counselor; the couple's decision was to terminate the pregnancy. The couple declined to have any fetal karyotyping or post-mortem examination. Termination of pregnancy was performed without any complications.

The couple was advised to undergo parental chromosome and genetic studies, which were normal. They were also counseled on the repetitiveness of the abnormality in future pregnancies since there was no family history of similar entities. However, we could not determine the risk of recurrence precisely.

The case presented above shows that an integrative effort by a fetomaternal specialist, radiologist, geneticist, and pathologist is important in establishing the diagnosis and making further management decisions.

Discussion

Radial ray malformations can be either unilateral or bilateral. Examination of the entire fetus helps determine whether there are associated anomalies[1]. Common associations include VACTERL (Vertebral defects, Anal atresia, Cardiac defects, Tracheo-Esophageal fistula, Renal anomalies, and Limb abnormalities, specifically of the radial ray), aneuploidy (trisomies 13 and 18), Holt-Oram syndrome, TAR (Thrombocytopenia-Absent Radius)[2,3], and Fanconi pancytopenia syndrome. Holt-Oram syndrome is a autosomal dominant disorder characterized by distinctive malformation of the bones of the upper limbs and abnormalities of the heart[4,5]. Cardinal manifestations include dysplasia of upper limb ranging from minor findings including hypoplasia of the thumb, clinodactyly, brachydactyly, triphalangeal thumbs, carpal bone dysmorphism, shortness of ulna, shortness of humerus and aplasia of radius to phocomelia and cardiac abnormalities. The left side is often affected more[6].

Radial ray anomalies comprise of a large spectrum of abnormvalities ranging from partial (radial hypoplasia) to complete (radial aplasia) deficiency of the radius +/- bones of the thumb. They are more common in males and in Caucasians[7]. Radial ray anomalies can be classified into four main subtypes depending on their severity[8,9].

Type I: The radius is slightly (>2 mm) short and the hand tends to bend sideways at the wrist (often associated with a hypoplastic thumb); the proximal radius is usually unaffected.
Type II: The radius bone is short and the ulna curves sideways and supports the wrist poorly.
Type III: Partial absence of the radius.
Type IV: Total absence of the radius.

The challenge associated with diagnosing radial ray anomalies can be overcome by combining clinical and ultrasound expertise with input from clinical genetics, ultrasound, and molecular testing.

A clinical algorithm which encourages targeted sonography including 3D views for subtle face, ear and hand anomalies, providing a useful tool to diagnose the underlying condition, is crucial for appropriate obstetric management and prognosticating for future pregnancies[10,11].

These are often described as heart-hand syndromes, characterized by radial ray deformities and congenital heart defects. Thrombocytopeniaabsent radius (TAR) syndrome, Roberts syndrome, thalidomide embryopathy, and Fanconi anemia are some of the associated abnormalities[12,13]. The unique feature that helps to differentiate the above associations from Holt-Oram syndrome is that radial aplasia here is associated with hypoplasia/absence of the thumb without any hematological abnormalities, and there is often a family history of heart defects[14]. The congenital heart defect present in these cases is the most important factor determining morbidity and mortality of patients. More than 85% of affected individuals have cardiac malformations, particularly ASD or VSD. Pulmonary stenosis, arrhythmias, and mitral valve prolapse are among other cardiac associations seen[15]. More complex cardiac lesions, such as tetralogy of Fallot, endocardial cushion defects, and total anomalous pulmonary venous return, are observed in 18% of subjects. The association with aortic atresia is extremely rare.

Conclusion

Radial ray anomaly in combination with ventricular septal defect is a rare and an interesting phenomenon which can be diagnosed in the prenatal period. Fetuses discovered to have abnormal limbs/hands should be referred to a center with expertise in evaluating the fetal skeleton by US and genetic counselling to help in the differential diagnosis and ensure proper management and follow-up.

Conflict of interest

The authors do not report any financial or personal connections with other persons or organizations which might negatively affect the content of this publication and/or claim authorship rights to this publication.

Author contributions

Original concept of study: AS. Writing of manuscript: AS, MA. Analysis and interpretation of data: AS, MA. Final acceptation of manuscript: AS. Collection, recording and/or compilation of data: AS, MA. Critical review of manuscript: AS.

References

1. James MA, McCarroll Jr HR, Manske PR: The spectrum of radial longitudinal deficiency: a modified classification. J Hand Surg Am 1999; 24: 1145–1155.
2. Jones KL, Jones MC, Del Campo M: Recognizable Patterns of Human Malformation. Elsevier, Philadelphia 2006.
3. Klopocki E, Schulze H, Strauss G, Ott C-E, Hall J, Trotier F *et al.*: Complex inheritance pattern resembling autosomal recessive inheritance involving a microdeletion in thrombocytopenia-absent radius syndrome. Am J Hum Genet 2007; 80: 232–240.
4. Goldfarb CA, Wall L, Manske PR: Radial longitudinal deficiency: the incidence of associated medical and musculoskeletal condition. J Hand Surg Am 2006; 31: 1176–1182.
5. Kaissi AA, Klaushofer K, Krebs A, Grill F: A novel malformation complex of bilateral and symmetric preaxial radial ray- thumb aplasia and lower limb defects with minimal facial dysmorphic features: a case report and literature review. Cases J 2008; 1: 271–275.
6. Wu C-J, Huang K-H, Liu J-Y: Prenatal 2D and 3D ultrasound diagnosis of radial ray defects. Int J Gynaecol Obstet 2011; 113: 158–159.
7. Minette MS, Sahn DJ: Ventricular septal defects. Circulation 2006; 114: 2190–2197.
8. Pakkasjärvi N, Koskimies E, Ritvanen A, Nietosvaara Y, Mäkitie O: Characteristics and associated anomalies in radial ray deficiencies in Finland – a population based study. Am J Med Genet A 2013; 161A: 261–267.
9. Sofer S, Bar-Ziv J, Abeliovich D: Radial ray aplasia and renal anomalies in a father and son: a new syndrome. Am J Med Genet 1983; 14: 151–157.
10. Bahtiyar MO, Dulay AT, Weeks BP, Friedman AH, Copel JA. Prenatal course of isolated muscular ventricular septal defects diagnosed only by color Doppler sonography: single-Institution experience. J Ultrasound Med 2008; 27: 715–720.
11. Sylwestrzak O, Respondek-Liberska M: Gradual diagnosis and clinical importance of prenatally detected persistent left superior vena cava with absent right superior vena cava – a case report and literature review. J Ultrason 2020; 20: e146–e150.
12. Roguin N, Du ZD, Barak M, Nasser N, Hershkowitz S, Milgram E: High prevalence of muscular ventricular septal defect in neonates. J Am Coll Cardiol 1995; 26: 1545–1548.
13. Yang PY, Yeh GP, Hsieh CT: Prenatal diagnosis of radial ray defects by ultrasound: a report of 6 cases. Taiwan J Obstet Gynecol 2018; 57: 598–600.
14. Moczulska H, Respondek-Liberska M: Prenatal diagnosis of Holt-Oram syndrome. Prenat Cardio 2015; 5: 29–32.
15. Paladini D, Russo M, Teodoro A, Pacileo G, Capozzi G, Martinelli P *et al.*: Prenatal diagnosis of congenital heart disease in the Naples area during the years 1994–1999 – the experience of a joint fetal-pediatric cardiology unit. Prenat Diagn 2002; 22: 545–552.