Ectopia cordis

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We report on a preterm male newborn with complete ectopia cordis associated with Cantrell's syndrome. The neonate had an ectopia cordis involving defects of the lower sternum, supraumbilical abdominal wall, anterior portion of the diaphragm, and diaphragmatic portion of the pericardium associated with complex congenital heart defects. The infant died shortly after birth. We discuss this case and review the literature.

Introduction

By definition, ectopia cordis (EC) is the presence of a live, beating heart outside the thorax and is one of the most unique congenital anomalies. The reported point prevalence is 5 to 8 per million live births.[1] To our knowledge, 91 cases of EC have been documented in published articles. We report our case and review the literature.

Case report

The 19-year-old mother was a primigravida, whose pregnancy had been normal until about 20 weeks of gestation in January 2010, when a prenatal fetal ultrasound revealed a cardiac anomaly (Fig 1). The fetal echocardiogram at 23 and 33 weeks of gestation showed evisceration of the heart and liver, a double-outlet right ventricle with malposition of the great arteries, severe pulmonary valve stenosis, moderate pulmonary artery hypoplasia, aortic and pulmonary valve insufficiency, and a perimembranous ventricular septal defect (VSD). There was no known consanguinity or a family history of congenital abnormalities. Cantrell's pentalogy was diagnosed, and the prognosis was discussed with the parents. Amniocentesis was performed for chromosomal analysis and revealed a normal male karyotype. The parents decided to continue the pregnancy.

At 35 weeks of gestation, a 2407-g male neonate was delivered vaginally, with an Apgar scores of 3 and 4 at 1 and 5 minutes, respectively. The beating heart and major vessels were covered with a serous membrane and completely visible in the middle of the chest wall. The lower half of the sternum and the upper abdominal wall were deficient and covered with a thin membrane. The liver had herniated through the upper abdominal wall, the umbilical cord being attached to the inferior portion of the abdominal wall defect (Fig 2). There were no other visible abnormalities. Comfort care was initiated until the infant died at 2 hours of age. The parents refused autopsy. A comparative genomic hybridisation array analysis (aCGH- Human Genome build: hg18) of a peripheral blood sample was normal.

Discussion

Because of its rarity and other associated abnormalities, EC is a challenging congenital anomaly. In complete EC (as in our case) the heart is entirely outside the thoracic cavity with or without a pericardial covering, and constitutes a neonate emergency. In partial EC, the heart can be seen to pulsate through the skin. Regarding the 91 known published cases, the heart was uncovered in 41%, covered with serous membrane (as in our case) in 31%, and covered by skin in 27%.[2]

As described by Engum[3] and Kaplan et al[4], the first report of EC was by Haller in 1706, and it was classified into different types by Weese in 1818 and Todd in 1836. Ectopia cordis may be grouped into cervical (3%), cervicothoracic (<1%), thoracic (60%), thoracoabdominal (7%), or abdominal type (30%). Thoracoabdominal EC has a better prognosis, whilst only a few patients with the thoracic type have survived and the cervical type is not compatible with life.[3]

Hypotheses regarding the aetiology of each EC class involve abnormalities in the development of mesoderm during early embryogenesis. The purported defects include the maturation failure of several midline mesodermal components, including the heart, sternum, rectus abdominis, diaphragm, and endocardium. The failure of cephalic anterior folds to fuse in a timely manner may result in the commonly associated anomalies found with EC. In the event of a true EC, the failure of sternal fusion appears to be secondary

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心臟異位

本文報告一宗與Cantrell綜合徵有關的完整心臟異位的早產男嬰病例。新生兒的心臟異位涉及胸骨下部、肚臍上方的腹壁、隔膜的前部、以及與複雜的先天性心臟缺陷有關的心包和膈肌部分缺損。嬰兒出生後不久死亡。本文報告此病例並回顧相關文獻。

FIG 1. An ultrasound image at 33 weeks of gestation shows the fetal heart (arrow) lying completely outside the thoracic cage

FIG 2. Photographs show (a) complete ectopia cordis, specifically an ectopic umbilicus with an upper abdominal wall defect, and (b) complete thoracic ectopia cordis with a 'naked heart' and great vessels

to a primary malposition of the heart itself. A failure of the heart to descend into the thorax during the third week of gestation may leave it trapped above the closing upper portion of the sternum, creating either a cervical or cervicothoracic ectopia.[3]

Some forms of EC may be better explained as a result of an amniotic band syndrome,[4] particularly for thoracic, thoracoabdominal, and abdominal types. Following rupture of the chorion at 3 weeks of gestation, amniotic band syndrome–derived EC develops as a result of interference with the normal descent of the heart due to mechanical compression and potential involvement of tissue bands causing mechanical teratogenesis. In thoracic EC, the occurrence of cephalic pointing at the cardiac apex may have a role. On the other hand, thoracoabdominal EC has been associated with the heart being tethered to para-umbilical structures by bands, though no definitive aetiological factors have been identified for this condition.[3]

The Cantrell's syndrome that is also known as the pentalogy of Cantrell (PC) is often found in association with EC. This syndrome consists of (1) a midline abdominal wall defect, (2) a caudosternal defect, (3) an anterior retrosternal diaphragmatic defect, (4) a pericardial defect, and (5) a congenital intracardiac defect.[5,6] Being a rare congenital syndrome, PC occurs in approximately 5 per million live births, with a male-to-female ratio of about 2:1; males also have more severe symptoms.[6] The risk of acquiring PC may be genetic, since familial cases have been described; a possible recessive X chromosome–linked inheritance has also been considered, whilst reported cases have also been associated with trisomy 13, 18, 21, and Turner's syndrome. Other associations with PC include viral infections, maternal abuse of beta-aminopropionitrile, and chlorine inhalation.[3,7]

Although the aetiology of PC remains unknown, the proposed mechanisms entail defects in embryogenesis around 14 to 18 days post-conception (during the splanchnic and somatic mesoderm divisions). As a result, the embryonic anomaly causes defective formation and differentiation of the ventral mesoderm. Kaplan et al[4] hypothesised that rupture of the chorion at around 21 days of gestation results in compression of the thoracic cavity preventing proper midline fusion of the developing chest wall.[4] Also, delayed retraction of the bowel in the embryo results in a structural defect in the central fibrous tendon of the diaphragm.[8] The occurrence of this syndrome is likely to be isolated and sporadic. Thus, PC has been classified into two groups. The first arises as a result of a mesodermal segment failing to develop correctly, resulting in diaphragmatic, pericardial, and intracardiac defects. The second arises due to paired primordial structures failing to migrate to their appropriate locations, leading to sternal and

abdominal wall defects.[3] Often the full spectrum of the PC is not complete, allowing several PC variants to be defined. In class 1, there is a definite diagnosis, with five defects; in class 2 (probable PC), there are four defects that entail the abdominal wall and intracardiac structures; in class 3, it entails incomplete expression, with a combination of defects present including those affecting the sternum.[9]

Intracardiac anomalies are consistently noted in PC. Specifically, there was a VSD in every published case in which a description of the heart was available (including our patient). Other commonly associated intracardiac defects include atrial septal defect (53%), valvular or infundibular pulmonary stenosis (33%), tetralogy of Fallot (20%), and left ventricular diverticulum (20%).[3] Other associated anomalies have been reported, including craniofacial and central nervous system anomalies (such as cleft lip/palate, and encephalocele), hydrocephalus, craniorachisis, limb defects (clubbed foot, absence of tibia and radius, and hypodactyly), and abdominal organ defects (agenesis of the gall bladder and polysplenia).[3,7,8,10,11]

Various diagnostic techniques are now available to screen for EC and PC. The prenatal diagnosis of these two defects is typically noted at the beginning of the second trimester; the earliest diagnosis was made at 10 weeks of gestation using Doppler sonography.[12] The use of three-dimensional ultrasound and its combination with Doppler allows for a more accurate early diagnosis. Magnetic resonance imaging is also becoming commonplace in prenatal evaluation to document and plan for management of complicated congenital anomalies.[13]

Regarding EC and PC, a number of interventional and palliative approaches are used. Immediate surgical correction of EC is often difficult, owing to inability to enclose the ectopic heart within a hypoplastic thoracic cage. Despite a reported high mortality, numerous successful corrective and palliative cardiovascular operations have been performed during the neonatal period, as well as infancy and childhood. For abdominal EC, it is recommended that the repair of the omphalocele along with the sternal, diaphragmatic, and pericardial defects should be undertaken urgently and concurrently. Hornberger et al[14] published data on 13 cases with EC, who survived beyond early infancy. The patients underwent successful cardiac repair and more definitive palliative treatment if they met two criteria—(1) no significant extracardiac defects, and (2) availability of adequate skin to cover the midline and heart defects after having their neonatal cardiac procedure.[14] Nevertheless, the viability of neonates having true thoracic EC with intracardiac anomalies was low. In an analysis of 239 cases of EC, of which 91 were truly thoracic EC, only one survived.[3] It is recommended that aggressive surgical procedures should be carried out without delay in the belief that this enhances viability. Overall, the prognosis appears dismal especially in patients having complete forms of EC and PC with associated extracardiac and intracardiac anomalies.[8,15] Our patient was a preterm and premature infant, as were at least one third of the cases reported in the literature. Surgical treatment attempted on preterm infants meets with variable success; one such patient survived 8 months.[16] To our knowledge, the cardiac defects in our patient (pulmonary artery hypoplasia, aortic and pulmonary valve insufficiency, and malposition of great vessels) have not been reported previously with PC.

In conclusion, we report an extremely rare and lethal case of a complete EC associated with the Cantrell's syndrome, and review the current diagnostic and management options for such patients. The prognosis of having either of these syndromes is poor despite early detection and intervention. However, early intervention on neonates born without extracardiac and intracardiac defects appears to result in better outcomes and longer survival than true EC patients with associated anomalies.

Acknowledgements

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