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ANATOMIC VARIATIONS

Autopsy findings of an isolated persistent left superior vena cava in an intrauterine dead fetus

Zeynep Çetin[1] · Ferah Tuncel[2] · Derya Erdoğan[2] · Orhan Beger[1] · Zeliha Kurtoğlu Olgunus[1]

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Abstract

Persistent left superior vena cava (PLSVC) is one of the cardiac system abnormalities with a 0.3–0.5% incidence and caused by inadequate obliteration of the left anterior cardinal vein during embryonic development. Prognosis of PLSVC is generally assumed to be good if it is not accompanied by other cardiac system abnormalities. During the routine ultrasound control of a patient at 25th week of pregnancy at the Obstetrics and Gynecology Department of Mersin University, PLSVC anomaly was detected in an intrauterine fetus. Then, intrauterine death occurred and after removal of the deceased fetus, PLSVC diagnosis was confirmed by autopsy. According to the autopsy findings, right superior vena cava (SVC) and azygos vein were found in normal course. PLSVC opened into the right atrium via enlarged coronary sinus. There was no connection between the two SVCs. On the left side of posterior mediastinum, instead of hemiazygos or accessory hemiazygos veins, a vein symmetrical to azygos was opened into PLSVC, similar to the one on the right. No other cardiac anomaly associated with PLSVC or any other pathology in the other parts of body that could be responsible for death was discovered during autopsy. There was no evidence indicating that PLSVC played any role in intrauterine exitus of the present case. However, as mentioned in the literature, the ectopic beats in the atrium wall of patients with isolated PLSVC and enlarged coronary sinus may lead to pathologies in the conduction system of the heart. Considering the intrauterine death of an isolated PLSVC case associated with cardiac conduction pathologies, we recommend that the common assumption of 'isolated PLSVC is not associated with death' should be reviewed by studies on large series and even intrauterine cases should be closely monitored for cardiac arrhythmia.

Keywords Persistent left superior vena cava · Fetus · Autopsy

Introduction

In the embryonic period, the right and left anterior cardinal veins provide venous drainage of the head of the fetus while the posterior cardinal veins provide venous drainage of the rest of the body. The anterior cardinal vein and the posterior cardinal vein merge on both sides to form the right and left common cardinal veins [9]. The left brachiocephalic vein which develops in the eighth week of gestation connects the two anterior cardinal veins. Then, the left anterior cardinal vein regresses and disappears in the sixth month. Coronary sinus formed by the left common cardinal vein opens into the right atrium. Persistent left superior vena cava (PLSVC) anomaly is the result of insufficient regression of the left anterior cardinal vein [18].

The anomalies of PLSVC were classified by Ancel and Villemin (1908) as follows: (a) no venous connection between the right and left superior vena cava (SVC), presence of the left duct of Cuvier, and absence of the left brachiocephalic vein, (b) small venous connection between two SVCs, presence of the left duct of Cuvier, and presence of small brachiocephalic vein, (c) normal venous connection between two SVCs, and (d) double SVC without venous atrophy [21]. Povoski et al. [17] reported the frequency of right SVC absence as 10–20%, and double SVC cases without anastomosis between right and left SVC as 65% in the PLSVC cases.

The PLSVC is a cardiac system anomaly with a prevalence of 0.3–0.5%, while the prevelance of this anomaly in

✉ Orhan Beger
obeger@gmail.com

[1] Department of Anatomy, Faculty of Medicine, Mersin University, Ciftlikkoy Campus, 33343 Mersin, Turkey

[2] Department of Pathology, Faculty of Medicine, Mersin University, Mersin, Turkey

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the population with a congenital heart disease is reported to be 4–11% [1, 11, 17]. PLSVC is usually isolated without any other anomalies. The isolated PLSVC is generally assumed to be asymptomatic and often incidentally discovered via cardiovascular imaging or surgery [4–6, 16, 17, 21]. On the other hand, 30–40% of the PLSVC was found to be associated with cardiovascular anomalies (atrial septal defect, bicuspid aortic valve, coarctation of aorta, coronary sinus ostial atresia, and cor triatriatum) [16, 18, 21]. Patients with PLSVC and enlarged coronary sinus have also been associated with cardiac conduction system disorders [6, 7, 14]. The prognosis of PLSVC varies according to the presence of other congenital heart diseases. It is assumed that if PLSVC is associated with other cardiac anomalies, its prognosis is worse, but in fetuses with isolated PLSVC, the prognosis is good and death is not expected [2, 16].

By paying attention that patients with isolated PLSVC might be more predisposed to arrhythmia, this report was aimed to evaluate the cardiovascular autopsy findings of an intrauterine dead fetus with this anomaly and to discuss the assumption 'isolated PLSVC is not associated with death'.

Case report

Routine ultrasound examination of a 23-year-old pregnant woman revealed that the male fetus had PLSVC. Due to the fact that the fetus died at 25 weeks of gestation without any apparent reason, the pregnancy was terminated with delivery. With consent of the family, an autopsy was performed in the Pathology Laboratory of the Mersin University. The head, chest, and abdominal cavities were opened, and no significant anomalies related to heart or other organs were discovered except for PLSVC.

Dissection results were as follows: in the superior mediastinum, SVC was found to be formed by right internal jugular and right subclavian veins, and left internal jugular and left subclavian veins joined together to form PLSVC (Fig. 1). There was no connection between the right SVC and PLSVC. Position of the heart was normal. Four cavities of the heart were opened and large vessels were examined. There was no atrial or ventricular septal defect. No pathology was observed in left and right atrioventricular orifice. Right ventricular and left ventricular wall thicknesses were normal. Due to the enlargement of the coronary sinus, the left atrium seemed to be pushed up slightly. One right and two left pulmonary veins were opened to the left atrium. No abnormality was observed in the heart except PLSVC and an enlarged coronary sinus and orifice (Fig. 2). Aorta, pulmonary trunk, inferior vena cava, and pulmonary veins were normal.

Measurements were done with a 0.01 mm precision digital caliper (Fig. 3). The diameter of the PLSVC was measured as 2.67 mm at above the pericardium and 3.44 mm at the level before entering the heart. PLSVC was descending at the border between the main cavity of left atrium and the left auricle of heart, and then continuing as coronary sinus. Width of the enlarged coronary sinus was found at the left end as 4.99 mm and at the widest part (midpoint) of the sinus as 5.71 mm. The width of the coronary sinus orifice was 5.04 mm, and the height was 3.47 mm. Diameters of the right superior vena cava, right internal jugular, and right subclavian vein were found as 3.00 mm, 1.38 mm, and 2.84 mm, respectively.

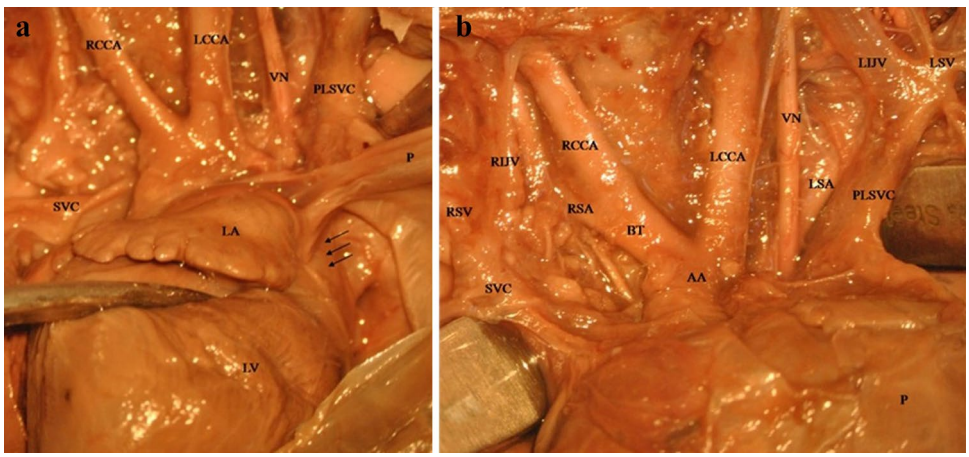

Fig. 1 **a** The extrapericardial and intrapericardial parts of PLSVC. **b** In situ appearance of the great vessels of heart at the superior mediastinum. *RCCA* right common carotid artery, *LCCA* left common carotid artery, *VN* Vagus nerve, *SVC* Superior vena cava, *RIJV* right internal jugular vein, *RSV* right subclavian vein, *RSA* right subclavian artery, *AA* aortic arch, *BT* brachiocephalic trunk, *LSA* left subclavian artery, *PLSVC* persistent left superior vena cava, *LIJV* left internal jugular vein, *LSV* left subclavian vein, *P* pericardium, *LA* left atrium, *LV* left ventricle

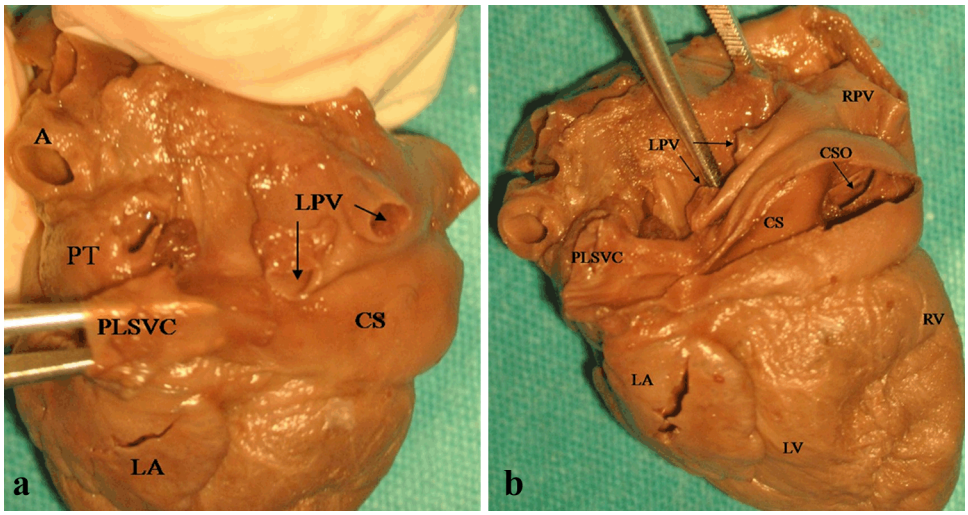

Fig. 2 Before (**a**), and after (**b**) cutting coronary sinus, posterior view of the heart. The connection of the PLSVC to the enlarged coronary sinus and the opening of the orifice of the coronary sinus to the right atrium. *PLSVC* persistent left superior vena cava, *LA* left atrium, *LV* left ventricle, *RV* right ventricle, *A* Aorta, *LPV* Left pulmonary veins, *RPV* right pulmonary vein, *CSO* orifice of coronary sinus, *PT* pulmonary trunk, *CS* coronary sinus

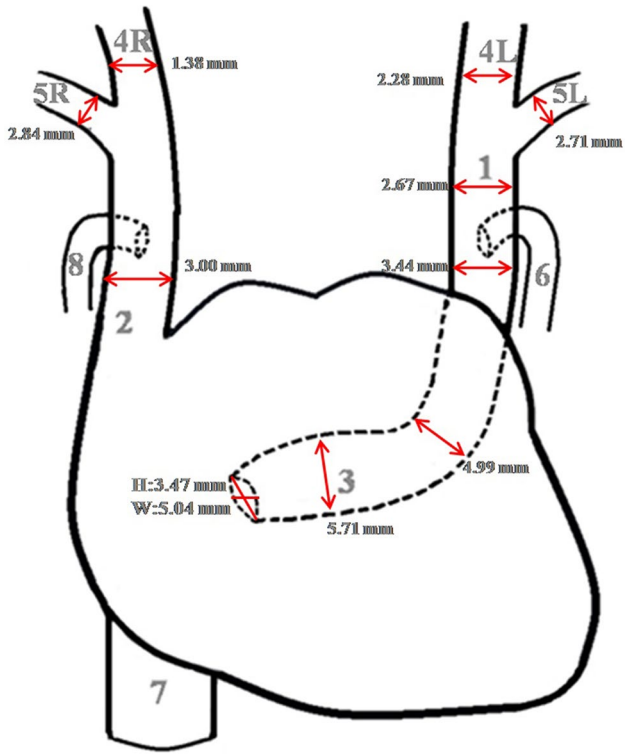

Fig. 3 Schematical drawing of the course of PLSVC and azygos veins as well as the measurements. 1: Persistent left superior vena cava, 2: Superior vena cava, 3: Coronary sinus, 4: Internal jugular vein, 5: Subclavian vein, 6: Left posterior mediastinal vein, 7: Inferior vena cava, 8: Azygos vein. *R* right, *L* left

On the right side, azygos vein was drained into the right SVC as normal, while a symmetrical vein from the left posterior mediastinum and bending from back to front just above the pulmonary root was drained into the PLSVC (Fig. 4).

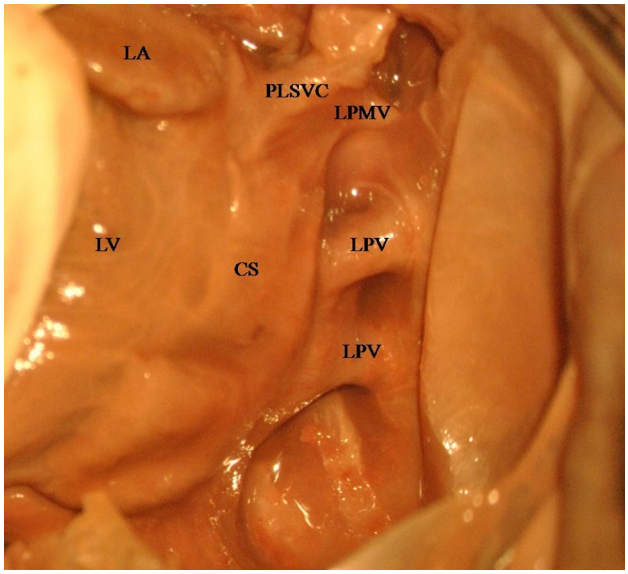

Fig. 4 Appearance of the left posterior mediastinal vein draning into PLSVC from the pericardial cavity. Apex of the heart retracted upward. *LA* left atrium, *LV* left ventricle, *CS* coronary sinus, *LPMV* left posterior mediastinal vein, *LPV* left pulmonary veins, *PLSVC* persistent left superior vena cava

Discussion

Considering the generally accepted developmental course of the veins in the region, this case with PLSVC accompanying left azygos vein might be the result of a series of deviations in the embryonic development such as failure in the development of precardinal anastomosis, persistence of the left anterior and common cardinal veins, and left horn of the sinus venosus, and persistence of proximal part of the left posterior cardinal and supracardinal veins. Taking into account that no other definitive evidence for the

cause of the intrauterine death could be obtained in this case with isolated PLSVC, whose prognosis is generally considered to be good when no other additional cardiac system anomaly is present, the literature was needed to be reconsidered regarding any sign for relation of the death with isolated PLSVC.

PLSVC may be accompanied by anomalies such as heterotaxia, isolated cardiac malformation, aneuploidy, complex malformation syndrome, and isolated extracardiac malformation [16, 20, 21]. This anomaly has also been associated with some triatrial heart types, where anomalous pulmonary veins drain into PLSVC at any point of its course [8]. In this case, pulmonary veins were draining into the left atrium as normal, while the left atrium seemed to be pushed up because of the enlarged sinus.

Diagnosis of isolated PLSVC cases is usually incidental via cardiovascular imaging, pacemaker implantation, radial imaging, and surgeries [3, 21]. Ari et al. [1] examined cases with congenital heart disease in patients with PLSVC. The ventricular septal defect (23.9%), double outlet right ventricle (14.8%) or Fallot tetralogy (11.4%) were reported in 50% of the patients with PLSVC [1]. In a retrospective study covering 4 years, 75% of the 32 prenatally diagnosed PLSVC cases were found to have concomitant cardiac or extracardiac anomalies, and 60% of those were dead in the intrauterine or postnatal period [1]. On the other hand, 25% of the PLSVC cases were isolated and all were alive [16]. Although death is not expected in isolated PLSVC cases, some studies associate this anomaly with disturbances in electrical activity focus [7, 13, 22]. Özsürmeli [16] did not mention any data about the presence or absence of cardiac conduction disorder accompanying the anomaly.

A focus of conduction system is described in the developmental horns of the coronary sinus. When the development of the heart is complete, the left horn disappears and the focus of right horn forms the sinoatrial node. If the left horn does not disappear, the focus may continue to produce electrical activity, which can lead to complications such as atrial fibrillation [7, 12, 22]. Weiss et al. [22] reported that there may be atrial tachycardia and conduction-type disorders related to atrioventricular node in patients with PLSVC cases with large coronary sinus ostium. Hsu et al. [7] concluded that PLSVC can be the arrhythmogenic source of atrial fibrillation in their five cases. Morgan et al. [13] reported that approximately 4% of 300 patients with arrhythmias had PLSVC. PLSVC might be a risk factor of cardiac conduction system dysfunction, leading to arrhythmias. It is reported that some of these arrhythmias, although rare, may result in death [12].

In this case, the exact cause of death could not be determined. While the case had not been examined for arrhythmia during pregnancy, it seems probable that a cardiac arrhythmia, such as atrial fibrillation, which is reported to occur more frequently in the presence of PLSCV, may be responsible for the intrauterine exitus of this case.

Opening of PLSVC into the right atrium via coronary sinus is reported in 80–90%, which is considered to have no hemodynamic consequences [6, 17]. It may open into the left auricle (atrium), pulmonary vein, right SVC or inferior vena cava as well [17, 21]. Awareness of possible existence and connections of PLSVC has been pointed out as critical during central venous access device placement. In any patient with possible PLSVC, it is crucial to reveal the pattern of cardiac venous return (i.e., to the right or left atrium and any accompanied right-to-left cardiac shunting) prior to central venous access device application [17]. Conventional contrast venography, transthoracic echocardiography, transesophageal echocardiography, multidetector computed tomography venography, and magnetic resonance venography could help to reveal the complete description of the central venous pattern [1, 17]. It should be kept in mind that difficulties may occur in venous vascular catheterization, coronary artery bypass surgery or pacemaker implantation in patients with double superior vena cava.

Another anatomical aspect of the case is related to symmetrical venous drainage of the posterior mediastinum. In cases where the vena cava superior is normal, the azygos vein on the right side of the mediastinum is opened into the vena cava superior, while hemiazygos and accessory hemiazygos veins of the left side are associated with azygos and left brachiocephalic veins [19]. In the presence of PLSVC, drainage of the veins from left mediastinum to the azygos vein of right side is very rare [15]. In this case, and also some of the PLSVC cases mentioned in literature [10, 15], right and left sides of the posterior mediastinum seem to have two symmetrical (i.e. paired) venous drainage routes. “Azygos” refers to a structure that is “unpaired” or "without bilateral symmetry". From this perspective, this case would like to question whether the terms of “right and left azygos veins” for such symmetrical posterior mediastinal veins of PLSVC cases are appropriate.

In conclusion, there is no clear evidence that PLSVC, whose prognosis is generally reported to be good when not accompanied by other cardiac system anomalies, has a role in this case of intrauterine death. Nevertheless, a limited number of studies in the literature suggests that an isolated PLSVC anomaly associated with an enlarged coronary sinus may be more likely than expected to have an overlooked pathology, such as atrial fibrillation, due to having an ectopic pacemaker atrial wall. Accordingly, the prevalent assumption that ‘isolated PLSVC is not associated with death’ should be reviewed in large series in terms of risk of death due to coexistence with cardiac conduction pathologies. Additionally, if the risk of death is higher than the normal population, those cases could be monitored more closely during the intrauterine period.

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Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest.

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