



Persistent Right-Sided Umbilical Vein and Azygos Continuity associated with Ophthalmological and Pulmonary Malformations. Prenatal Diagnosis of an Exceptional Case

Sylvie Lepage^{*}, Xavier Capelle, Patrick Emonts, Frederic Kridelka, Marie-Christine Seghaye and Christine Van Linthout

Liege University Hospital (Hospital Sart Tilman), Hospitals & Clinics in Cork, Domaine Universitaire du Sart Tilman Bat. B35 Liège, Belgium

^{*}Corresponding author: Sylvie Lepage, Liege University Hospital (Hospital Sart Tilman), Hospitals & Clinics in Cork, Domaine Universitaire du Sart Tilman, Belgium, Tel: 0032495795564; E-mail: Syl.lepage@gmail.com

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Abstract

We report on the case of a fetus in whom a prenatal ultrasound performed at 22 weeks of gestation allowed the diagnosis of a double anomaly of the systemic venous return, with a persistent right umbilical vein and the agenesis of the inferior vena cava with azygos continuity.

The fetus showed also a large umbilical hernia and a right sided microphthalmia. Fetal growth was normal. Genetic anomalies were excluded by karyotype and CGH array. Cesarean section was performed at 39 weeks of gestational age for breech presentation. The neonate adapted well. Post-natal examination confirmed pre-natal diagnosis. Thoraco-abdominal CT-scan performed at 8 days of age showed additional right upper lobe bronchial atresia with relative hypoplasia of the right pulmonary artery and right hepatic lobe hypotrophy. It also showed a short segmental infra diaphragmatic aplasia of the vena cava with dilation of the azygos vein running along the homolateral diaphragmatic coupola that drained into superior vena cava and malposition of the mesenteric vessels without any intestinal malrotation. Anomalies of the fetal cardinals and umbilical veins are the result of early abnormal venous system development in the embryo, the etiology of which is unknown. Usually, abnormal systemic venous return only affects one vessel. The presence of a double anomaly as described in this case is exceptional.

A persistent right umbilical vein is reported in 0.2 to 0.4% of antenatal screening. The variant with intrahepatic transition is the most frequent and isolated form. The exceptional, form with hepatic bypass, is commonly part of a polymalformative syndrome. Agenesis of the inferior vena cava (IVC) with azygos continuity is a rare anomaly (0.2-3% of antenatal screening). Its significance relates to its frequent association with complex congenital heart diseases. The prognosis of anomalies of cardinals and umbilical veins depends on the presence of associated cardiac and extra cardiac malformations that might impact prenatal counseling and parental decision to continue or interrupt pregnancy. Careful repeated pre and post-natal evaluation is necessary to exclude polymalformative syndrome despite of normal molecular genetic examination.

Keywords: Umbilical vein; Polymalformative syndrome; Cardiac malformations; Ocular prosthesis

Case Report

We report on the case of a 22 years-old Caucasian primiparous patient with no significant past medical history referred for a second trimester screening ultrasound.

The fetal exam notes the absence of the vena cava inferior (VCI), of the left umbilical vein and of the ductus venosus (DV) concomitant with a persistent right umbilical vein. The latter, located along the right hepatic lobe, drains into a dilated azygos vein (Figures 1-4).

An umbilical hernia is also present. The fetal echocardiography demonstrates a dilated right atrium with a tricuspid regurgitation without valve anomaly. An amniocentesis identifies a normal 46XX karyotype without significant microdeletion or microduplication.

The ultrasound follow-up, performed 4-weekly, does not show any sign of growth restriction or of cardiac failure. A cesarean section is performed at 39 weeks for breech presentation and gives birth to a

3220 g and 495 cm baby girl. The postnatal cardiac adaptation is considered satisfactory. A significant umbilical hernia and a right microphthalmia are noted. At postnatal cardiac ultrasonography, the venous malformations are confirmed. The heart is otherwise morphologically normal.

Thoraco-abdominal angio-CT scan confirms the segmental agenesis of the VCI between the supra-renal level and the right atrium. The hepatic veins drain directly into the right atrium and the superior mesenteric artery is positioned right to the superior mesenteric vein with no situs inversus of the other abdominal organs.

At the thoracic level no isomerism is noted but an agenesis of the right superior lobar bronchus with concomitant congenital emphysema.

Cerebral MRI notes no cerebral anomaly but confirms an ocular lesion with a right microphthalmia, a right optic nerve- and a right-sided chiasm hypoplasia. The evolution of the child is satisfactory after a follow-up period of 3 years. The ocular globe will be prepared for an ocular prosthesis. There was no indication to treat the lobar emphysema and the umbilical hernia.

Discussion

Embryological background

The embryo has three coexisting venous systems, all of them draining into the venous sinus and each having a specific function. The vitelline system drains the gastro-intestinal tract while the umbilical system receives the oxygenated blood from the placenta and the cardinal system collects the blood from the head, the neck and the body wall (Figure 1).

The right umbilical vein undergoes a complete regression during the second month of fetal life while the left umbilical vein persists although losing its connection with the left horn of the venous sinus. The O₂ enriched blood drains into the VCI where it enters the right atrium via the intrahepatic DV. This canal has a major regulatory function on the fetal circulation due to its sphincter effect and plays a key role in delivering oxygen to the brain and the myocardium. Secondary to the physiological diameter reduction of the DV, the blood flow increases significantly. This allows the oxygenated blood to selectively cross the foramen ovale and to drain into the left atrium, to reach the left ventricle and the ascending aorta, and thus the coronary and the brain vessels without being mixed with deoxygenated blood issued from the inferior and the superior vena cava [1-5].

A persistence of the right umbilical vein has an incidence of 0.2 to 0.4% and is secondary to an embryonic anomaly of unknown origin. Several causes are suggested amongst which the exposure to a teratogen agent, a folic acid deficit or a left umbilical vein compression and subsequent regression [6]. The position of the right persistent umbilical vein may vary. In its intrahepatic variant, the right umbilical vein drains into the portal system and the DV is present. In the extra hepatic variant, the right umbilical vein drains into the systemic circulation and bypasses the liver. The DV is then absent [7-12].

The VCI and the azygos vein originate from the cardinal system. The VCI collects the blood issued from the lower limbs, the pelvis and the abdominal organs. The azygos vein collects the blood from the lumbar and the right intercostal veins and drains into the superior vena cava. The agenesis of the VCI with azygos continuity is a rare abnormality of the systemic venous return (0.6% of all congenital cardiac malformations). The absence of the VCI affects mainly the infrarenal portion of the vena cava. The suprarenal portion of the VCI will be in continuity with the azygos vein that drains into the superior vena cava. The supra-hepatic veins drain directly into the right atrium [13-16].

Ultrasound Features

The diagnosis of a segmental VCI interruption with azygos continuity is made on a crosssection of the superior abdomen and on the cardiac 4-cavity section. On the superior abdominal cross-section (Figure 2), the VCI, physiologically positioned right and anterior to the aorta, cannot be visualized and the azygos vein is seen immediately right and slightly posterior to the aorta with a caliber similar to that of the aorta. On the 4-cavity section, the characteristic image of the « double vessel » is described and corresponds to the aorta and the azygos vein on its right (Figure 3) [13].

In the case of a persistent right umbilical vein, its position will be determined on the abdominal circumference section using the color Doppler, the umbilical vein being located on the right of the gallbladder and not in its medial position.

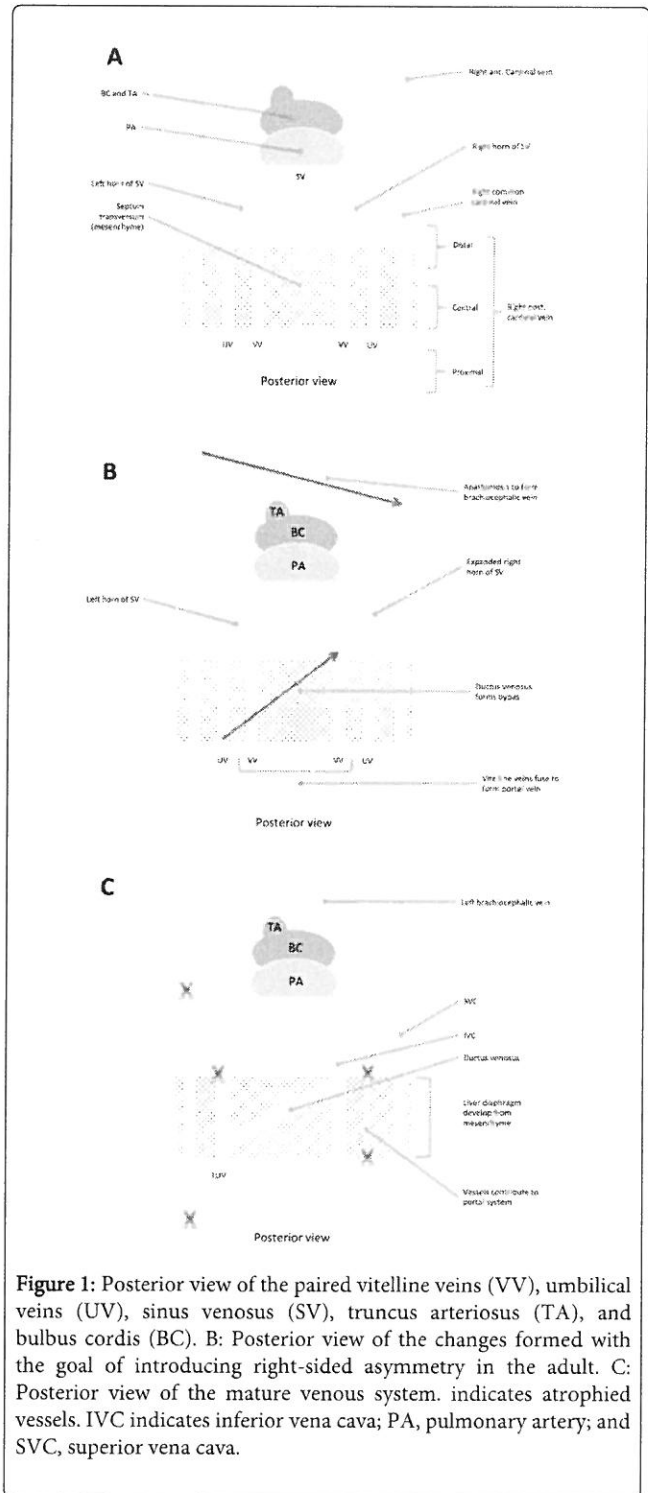


Figure 1: Posterior view of the paired vitelline veins (VV), umbilical veins (UV), sinus venosus (SV), truncus arteriosus (TA), and bulbus cordis (BC). B: Posterior view of the changes formed with the goal of introducing right-sided asymmetry in the adult. C: Posterior view of the mature venous system. indicates atrophied vessels. IVC indicates inferior vena cava; PA, pulmonary artery; and SVC, superior vena cava.

Also, the intrahepatic- must be distinguished from the extra hepatic variant and the agenesis of the DV must be suspected (Figure 4) [12]. In the reported case, the azygos vein is markedly dilated and has a diameter greater than that of the aorta because it collects the blood

issued from the lower body but also the blood from the right umbilical vein that bypasses the liver and drains directly into the azygos vein.



Figure 2: Agenesis of the hepatic segment of VCI, aorta (AO) in median position in front of the spine (Sp), and azygos (Az) vein dilated located further back in the right para vertebral space. Stomach (St)



Figure 3: 4-cavity section of the heart. Image of the « double vessel ». Aorta (Ao), Azygos vein (Az)

The right atrium is also slightly dilated with a moderate degree of tricuspid regurgitation with no signs of cardiac failure. The DV is absent.

Prenatal evaluation

When the persistent right umbilical vein is not associated with other anomalies and is connected directly to the portal system with no hemodynamic changes, it must be considered as a variant of the normal fetal anatomy [6,10].

When the DV is absent, the prognosis will depend on the type of cardiac- and extra cardiac malformations that are frequently associated (45% of cases), on the chromosome abnormalities and on the potential presence of a portal agenesis and of a Noonan's syndrome.



Figure 4: Abnormal course of the right umbilical vein (Vo) adjoining the thorax wall that bypasses the liver and drains into the azygos. Aorta (Ao)

The risk of cardiac congestion is also increased in case of an extra hepatic drainage of the umbilical vein due to an overload of the systemic venous return [17-19].

In the reported case, we observe an agenesis of the DV with an extra hepatic persistent right umbilical vein draining into the azygos vein and associated with a segmental interruption of the VCI. In this setting, no intrahepatic resistance is opposed to the umbilical blood flow. Consequently, a major venous return to the right atrium is present and is potentially responsible of a congestive cardiac failure with a subsequent intrauterine or neonatal death in more than 20% of cases [17].

Moreover, under these conditions, the accelerated umbilical blood flow noted physiologically in the DV is absent and the oxygenated blood of placental origin is no longer preferentially oriented to the left atrium.

As noted by Jaeggi, et al. the absence of DV does not appear to affect the fetal oxygenation compensated by a massive venous return through the umbilical vein into the right atrium. Furthermore, the increased blood flow into the right atrium associated with DV agenesis stimulates the secretion of the natriuretic peptide that leads to the development of a hydramnios in a third of the cases [17].

The agenesis of the VCI may be isolated in which case the prognosis is excellent [15]. In most cases however, it is linked to a left isomerism with polysplenia or may be part of complex congenital cardiac malformations. Exceptionally, agenesis of the VCI is associated with an umbilical venous malformation, as we reported here [20,21].

When such a condition is suspected at antenatal ultrasound, a cautious morphological and a cardiac evaluation must be performed. An MRI may be indicated in order to rule out other extra cardiac abnormalities such as a polysplenia syndrome that is present in 90% of the cases of left isomerism.

The karyotype must always be verified. A specialized post-natal evaluation is mandatory. Pulmonary abnormalities such as those described in this case may be overlooked at the prenatal exam.

Conclusion

The association of a persistent right umbilical vein and the absence of IVC is exceptional. A combined embryological defect involving concomitantly the cardinal and the umbilical venous systems [1,3,5].

A persistent right umbilical vein is noted in 0.2 to 0.4% of pregnancies. The intrahepatic variant with persistence of the DV is the most frequently reported form and is then isolated. In the extrahepatic form with absence of the DV, the venous return into the right atrium can be significant and cause a congestive heart failure. In such circumstances, additional abnormalities are described.

The IVC agenesis with azygos continuity is equally rare (0.2 to 3%). Its impact is related to its frequent association with complex congenital cardiopathies [15].

A detailed analysis of the abdominal and thoracic vasculature allows this diagnosis of this rare abnormality to be made. The combination of these two conditions and the absence of an DV justifies the significant dilatation of the azygos vein described in this case. A precise work-up of all potentially associated abnormalities allows the clinician to optimally define the prognosis and the follow-up of such a rare condition.

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