Three Cases of Asplenia Syndrome Associated with Congenital Heart Disease

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Case Reports

Case 1. A 6-year old boy was admitted to the Seoul National University Hospital for the evaluation of known congenital heart disease. He was first recognized to have a cyanotic congenital heart disease when he visited a local clinic because of neonatal jaundice. He had experienced frequent attacks of upper respiratory infection since birth and at 3 years of age the circumoral cyanosis, dyspnea and squatting on exertion had begun to develop.

Physical examination revealed a cyanotic boy with clubbed fingers and toes. There was a harsh and blowing systolic murmur at the left sternal border. The liver edge was just below the right costal margin.
In the red cells of the peripheral blood, Howell-Jolly bodies were found. The electrocardiogram showed sinus rhythm with right ventricular hypertrophy and right axis deviation.

The chest roentgenogram (Fig 1-A) showed the heart in the left hemithorax with no gross cardiomegaly. The pulmonary vascularity was slightly decreased and the pulmonary conus was concave. The aortic knob was on the left and was slightly enlarged. The stomach gas shadow was under the right diaphragm. The bronchial branching pattern was that of situs solitus, which was confirmed by bronchial tomography. Barium meal gastrointestinal study (Fig. 1-B) revealed the right-sided stomach with a vertically positioned antrum and ipsilateral duodenal bulb. The small and large bowels were in normal position.

The liver scan with $^{99m}$Tc-phytate showed the transverse liver with right side predominancy. The spleen scan with $^{51}$Cr-tagged RBC revealed no splenic uptake.

The catheterization data are presented in Table I. The venous catheter inserted in the right saphenous vein passed through the left-sided inferior vena cava which crossed the midline at its hepatic segment to reach the right-sided right atrium. Injection of contrast material into both
saphenous veins confirmed the peculiar course of the inferior vena cava (Fig. 1-D). A group of hepatic veins were seen to fill directly from the IVC at its entrance into the atrial cavity. After injection of contrast material into the right-sided ventricle, a morphologic right ventricle was visualized. The left-sided morphologic left ventricle was opacified through the ventricular septal defect. The great vessels were opacified and were normally interrelated. The pulmonary artery arose from the right ventricle and the aorta arose mainly from the left ventricle with minimal overriding the ventricular septum. There was a combined infundibular and valvular pulmonary stenosis (Fig. 1-C, E). The clinical and angiocardiographic diagnosis of tetralogy of Fallot was confirmed by surgery.

Case 2. A 9-year old girl was admitted to the Seoul National University Hospital for the evaluation of the known congenital heart disease. The patient had been cyanotic and had frequent attacks of upper respiratory infection since birth. At 100 days of age, she was found to have a heart murmur at a local clinic.

Physical examination revealed a cyanotic girl with slight emaciation and bulging of her left precordium. A grade IV, harsh and blowing systolic murmur was heard at the left sternal border. The liver edge was 2 finger breadth below the right costal margin.

In the red cells of the peripheral blood, Howell-Jolly bodies were found. The electrocardiogram showed sinus arrhythmia and right ventricular hypertrophy.

The chest roentgenogram (Fig. 2-A) showed slightly enlarged heart in the left hemithorax with slightly decreased pulmonary vascularity. The stomach gas shadow was located at some distance below the right diaphragm. The bronchial branching pattern was that of situs solitus. Barium meal gastrointestinal study (Fig. 2-B) confirmed the position of stomach on the right. The duodenal bulb and the entire small intestine were on the left side of abdomen, and the entire colon was on the right and ipsilateral to the stomach. Overall gastrointestinal arrangement was that of situs inversus with 2nd degree malrotation of midgut loop.

The liver scan with 99mTc-phytate showed transverse liver with right side predominance. The spleen scan with 51Cr-tagged RBC revealed no splenic uptake.

The catheterization data are presented in Table I. The venous catheter inserted in the right saphenous vein showed the similar course of the inferior vena cava to that of case 1, i.e., the left-sided inferior vena cava crossing the midline at its hepatic segment to enter the right-sided right atrium. Injection into the left atrial cavity showed simultaneous opacification of the smaller hypoplastic left ventricle and the larger coarsely trabeculated right ventricle (Fig 3-A). The main portion of right ventricle was on the right and anterior
from the left ventricle and pulmonary artery from the right ventricle (Fig 3-B, C, D). There was a combined infundibular and valvular stenosis. Partial anomalous pulmonary venous return and left superior vena cava were associated. Final diagnosis of cardiac malformation was \([\text{A(S), D, S}}\) double inlet right ventricle with normally related great arteries.

**Case 3.** A 7-year old girl was admitted to the Seoul National University Hospital because of the deepening cyanosis which had been present since birth. She had experienced frequent attacks of upper respiratory infection. Dyspnea and squatting on exertion had begun to develop insidiously from the early childhood.

Physical examination revealed cyanotic girl with growth retardation and right precordial bulging. A grade III/IV, harsh systolic murmur was heard along the right sternal border. The liver was not palpable.

No Howell-Jolly bodies were found. But the findings suggestive of splenic hypofunction were seen in the peripheral blood. The electrocardiogram showed sinus arrhythmia and right ventricular hypertrophy. There was negative P waves in lead I and AVL, and positive P waves in lead III and AVF, suggesting the inversion of atrial situs (Fig 4-B).

The chest roentgenogram (Fig 4-A) showed the heart in the right hemithorax with moderate cardiomegaly and decreased pulmonary vascularity. The aortic knob and descending aorta were on the left side. The cardiac apex was round and elevated. The stomach gas shadow was located at some distance below the left diaphragm. The branching pattern of tracheobronchial tree was unusually symmetrical. Unfortunately barium meal gastrointestinal study was not done.

The liver scan with \(^{99m}\text{Tc-phytate}\) showed the
transverse liver with left side predominency. The spleen scan with $^{51}$Cr-tagged RBC revealed no splenic uptake (Fig 4-C, D).

On catheterization, the course of the venous catheter introduced through the right saphenous vein revealed the possibility of interruption of the right-sided inferior vena cava with azygos continuation. The catheter could not be advanced more after it reached the right cardiac border. Injection of contrast media at that point con-

Fig. 3. Cineangiocardograms of case 2(double inlet right ventricle {A(S), D,S}). A. Frontal view of left atrial injection; Injection into left sided left atrium shows simultaneous opacification of the smaller left ventricle and the larger right ventricle. The catheter course is through the left-sided inferior vena cava and the right-sided right atrium. The catheter crosses the midline at the level of diaphragm. B. Lateral view of left ventricular injection; Injection into the smaller left ventricle mainly opacifies the aorta which arises from it. See the aorticomitral continuity and the regurgitation of contrast into the left atrial cavity. The catheter course is from the aorta to the left ventricle. C and D. Frontal and lateral views of right ventriculography; Injection into the right ventricle mainly opacifies the pulmonary artery. The great arteries are normally related and connected. The catheter course is from the right superior vena cava to the right ventricle through the right atrium.
firmed ipsilateral azygos continuation of the interrupted inferior vena cava (Fig 5-A). The azygos vein entered the ipsilateral superior vena cava which drained into the contralateral left-sided right atrium. Filling of the hepatic veins could be seen from the right atrial chamber. Following the right atrial opacification, the morphologic right ventricle and the aorta with subaortic conus were visualized (Fig 5-C). The aorta was left ascending and left descending. In the venous phase, the left atrial chamber was opacified just below the carina (Fig. 5-D). The left atrium was superior to and right side of right atrium and drained into the amorphologic left ventricle which occupied the cardiac apex on the right. The pulmonary artery was located on the right posterior aspect of aorta and had pulmonary stenosis (Fig 5-B). Catheterization and angiocardiography through the basilic vein could not be performed because of the patient’s poor condition. Operation confirmed the cineangiographic diagnosis of \( A(l), L, L \) complete transposition with interruption of the inferior vena cava. The mitral hypoplasia was newly diagnosed and both lungs were bilobed.

**Discussion**

Although many paired structures of the body are normally symmetrical (e.g., brain, kidneys), several paired viscera are asymmetrical (e.g., tracheo-bronchial trees, lungs, atria). Solitary
Fig. 5. Cineangiocardograms of case 3 (Complete transposition of the great arteries). A(I), L,L.). A. Early phase of injection into the azygos vein which receives the interrupted inferior vena cava; Ipsilateral superior vena cava is opacified and drains into contralateral right atrium. See the regurgitation into hepatic veins (hv). B. Lateral view showing anterior position of aorta with infundibulum. C. Arterial phase of A; The aorta arises from the right ventricle which receives the right atrium. D. Venous phase of C; The left atrial chamber is opacified below the carina. The left atrium is superior to and right side of the right atrium and drains into the left ventricle which occupies the cardiac apex.

structures, such as the liver, spleen and gastrointestinal tract, have a specific rightward or leftward orientation within the abdominal cavity. The positions of these asymmetric structures express the situs or body configuration of an individual. Classical asymmetric body configuration have been divided into situs solitus and situs inversus. In situs solitus, the right lung has three lobes and eparterial bronchus while the left lung has two lobes and hyparterial bronchus. The larger lobe of the liver is on the right, and the stomach and spleen are on the left. In situs inversus, the left lung has three lobes and the right has two. The larger lobe of the liver is on the left while the stomach and spleen are on the right. Situs ambiguus is anatomically uncertain or
indeterminate situs in which more or less symmetric arrangement of viscera is present. The situs ambiguous is most often associated with congenital asplenia, less often with polysplenia and rarely with a normally formed spleen.\textsuperscript{1,2,3} The asplenia syndrome is characterized by "bilateral right-sidedness" with duplication of right-sided structures and absence or displacement of left-sided structures. Both lungs are trilobed and have eparterial bronchi; both atria morphologically resemble right atria; the liver is symmetrical and horizontal; and the gastrointestinal tract is malposed or malrotated. The polysplenia syndrome is characterized by "bilateral left-sidedness" including bilateral left atria and bilateral left lung with bilateral hyparterial bronchi.

Van Mierop explained the absence of spleen in syndrome of "bilateral right sidedness" and the presence of multiple spleens in syndrome of "bilateral left-sidedness" as follows:

"The spleen is the only organ in the body which is left-sided from its inception; it normally develops in the leftside of the dorsal mesogastrium. Since presumably in asplenia syndrome there is no true left side, a spleen cannot develop. In polysplenia syndrome, on the other hand, both sides of the dorsal mesogastrium have left-sided potential, and splenic tissue develops on both sides."

The asplenia syndrome occurs in less than 6 per a million.\textsuperscript{4} Males predominate over female in a ratio of 1.7-2:1.\textsuperscript{1,2,3} Complex and multiple congenital heart diseases are the rule in asplenia syndrome and almost always they are cyanotic. Only a few cases of asplenia syndrome without heart disease are reported in the literature. This complexity of cardiac malformation determines the clinical course and prognosis. Actually about 80% of patients with asplenia syndrome die by the end of first year mainly due to the associated cardiac malformations.\textsuperscript{2}

The clinical picture of asplenia syndrome begins with cyanosis in the neonatal period. With the exception of a horizontal liver, the physical findings are not peculiar to asplenia syndrome.\textsuperscript{1,3}

The chest roentgenographic features including malposition of the heart, pulmonary undercirculation, symmetry of tracheobronchial, a symmetric and horizontal liver and malposition of the stomach usually alerts the clinician to the presence of asplenia syndrome.\textsuperscript{1,2,3} When the conventional chest roentgenogram fails to visualize the branching pattern of tracheobronchial tree, this should be ascertained by high kilovoltage technique or tomography.\textsuperscript{1,2,3} The presence of bilateral eparterial bronchi is said to be the pathognomonic for asplenia syndrome,\textsuperscript{1} but a few cases of asplenia syndrome have been reported in which the tracheobronchial trees were not bilaterally eparterial as in our 3 cases.\textsuperscript{2,4,5,6,7,8}

Electrocardiographic findings are not helpful in asplenia syndrome. The presence of Howell-Jolly bodies and Heinz bodies in the red cells of the peripheral blood is strong but not conclusive evidence for asplenia syndrome because they can be transiently present in the normal new born. These inclusion bodies are also seen in the late stage of the maturing erythroblast, in megaloblastic and hemolytic anemia, leukemia and some types of steatorrhea. Our case 1 and case 2 showed Howell-Jolly bodies in the peripheral red blood cells. The peripheral blood smear of the case 3 showed no Howell-Jolly bodies but showed only the suggestive findings of splenic hypofunction.\textsuperscript{1,2}

A more specific diagnosis of asplenia can be made by radioisotope scanning of the liver and spleen when the splenic uptake is absent.\textsuperscript{9,10}
Some technical errors and the diseases with hypo-function of the spleen are responsible for false positive results. A symmetric and horizontal liver is present in over half of the cases.1,2,9)

Barium meal gastrointestinal study usually demonstrates the abdominal heterotaxy. In about half the cases of asplenia syndrome, the stomach is located in the right and rarely in the midsagittal plane. Varying degree of midgut malrotation is usually present.1,2,11)

Catheterization and angiocardiology confirm the associated cardiovascular malformations. The cardiac anomalies most frequently associated are: 1) large atrial septal defect or common atrium; 2) atrioventricular canal; 3) common or single ventricle; 4) transpositions or malpositions of the great arteries; 5) severe pulmonary stenosis or atresia; 6) anomalous pulmonary venous connection.1,2,3) There is no report of tetralogy of Fallot with asplenia syndrome in the literature.2) But our case 1 is an unequivocal case of tetralogy of Fallot. Angiographic demonstration of juxtaposition of the inferior vena cava and abdominal aorta furnish further evidence for asplenia syndrome.1,2,12) And our case 1 and case 2 had the juxtaposition of the two. Interrupted heaptic segment of inferior vena cava with azygos continuation is reported as a strong angiographic evidence for polysplenia syndrome and is rare in asplenia syndrome. But there are a few reports of frequent association of interrupted inferior vena cava and asplenia syndrome.4,13) In our case 3, both lungs were bilobed and the inferior vena cava was interrupted, but we considered it as asplenia syndrome because there was no reason for absence of splenic uptake on spleen scan other than congenital absence. But, non the less, the diagnosis is not complete.

In summary, the most reliable evidences of asplenia syndrome are bilateral eparterial bronchi, Howell-Jolly bodies and Heinz bodies in peripheral blood smear and absence of spleen on spleen scan. But each of them really has false positive and false negative results, as stated above. When there are only one or two of the above three evidences, other supportive findings such as, juxtaposition of abdominal aorta and inferior vena cava, gastrointestinal malposition and malrotation, etc., should be included.

Authors presented two conclusive cases and one strongly suggestive case of asplenia syndrome with congenital heart disease, in which cardiac catheterization and angiocardiology were done at the Department of Radiology, Seoul National University Hospital.

REFERENCES


