

Double outlet right ventricle in a calf

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Abstract Double outlet right ventricle is a conotruncal malformation where both great arteries (aorta and pulmonary trunk) arise from the right ventricle. A 2-month-old Holstein calf was slaughtered due to severe respiratory distress. At necropsy, the heart was enlarged, globose, and had ventricular and atrial septal defects. The only outlet for the left ventricle was a large ventricular septal defect located at 6 cm distance from the heart apex and involved atrial septum too. The right ventricle was enlarged and markedly thickened with a left to right free wall ratio of 2.5:2 and prominent papillary muscles. The aorta arose from the right ventricular infundibulum adjacent to pulmonary trunk. Two valvular hematomas were observed on the edge of the right atrioventricular valve. The lungs were rubbery with ecchymotic and petechial hemorrhages and did not collapse after removing from thoracic cavity. Enhanced lobular pattern was evident on both the capsular and cut surfaces of the liver. Histopathological examination of the lungs revealed thickening of alveolar septa, hemor-

rhages, and infiltration of hemosiderophages within alveoli. Periportal hepatocellular fatty changes, substitution of centrilobular and midzonal hepatocytes by red blood cells, and dilation of midzonal and periportal sinusoids were seen in the liver. To our knowledge, this particular combination of cardiac defects has not been previously described in domestic animals and the pathological lesions observed in the calf may be resulted as a sequel to left–right blood shunting and heart failure.

Keywords Double outlet right ventricle · Ventricular and atrial septal defects · Calf · Pathology

Introduction

Double outlet right ventricle (DORV) is a conotruncal malformation where both great arteries (aorta and pulmonary trunk) arise from the right ventricle (Prosek et al. 2005). This anomaly has been described in veterinary literature in few cats and dogs, a foal, and three calves with variable clinical and pathologic findings (Wilson et al. 1985; Zulauf et al. 2001; Prosek et al. 2005).

In this article, we describe gross and histopathological characteristics of DORV in a calf with concurrent ventricular and atrial septal defects and tricuspid valvular hematomas. To our knowledge, this particular combination of cardiac defects has not been previously described in domestic animals.

Case history

A 2-month-old Holstein calf was slaughtered due to severe respiratory distress and referred to Department of

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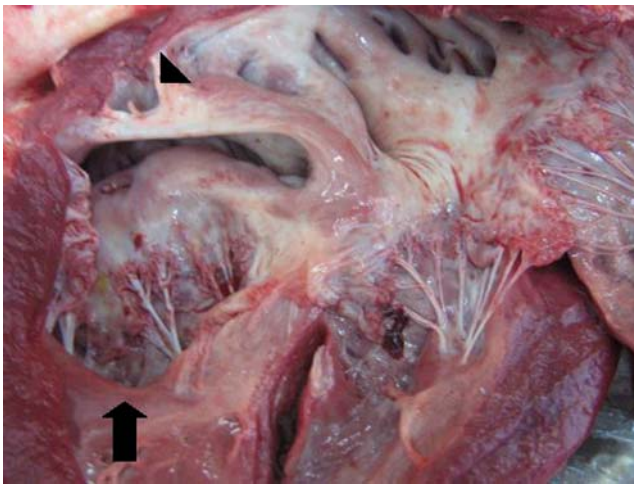


Fig. 1 Ventricular and atrial septal defects with the left ventricle opened. Note the large ventricular (*arrow*) and small atrial (*arrow-head*) defects in the septa

Pathobiology, Faculty of Veterinary Medicine, University of Shahrekord. At necropsy, for histopathological examination, tissue samples from liver and lungs were fixed in 10% neutral buffered formalin. They were processed and embedded in paraffin. Sections of 6 μm thick were stained with hematoxylin and eosin.

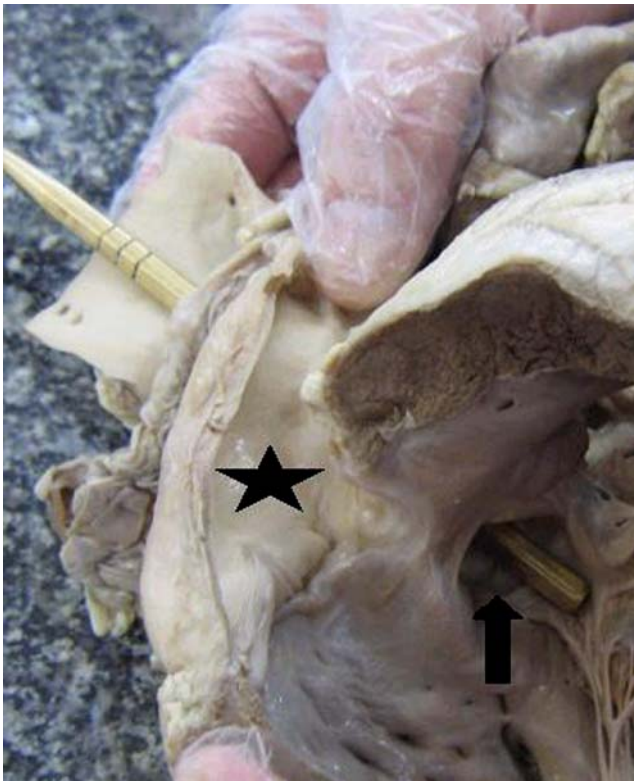


Fig. 2 Double outlet right ventricle. The aortic valve (*arrow*) is seen adjacent to the pulmonary trunk (*star*)

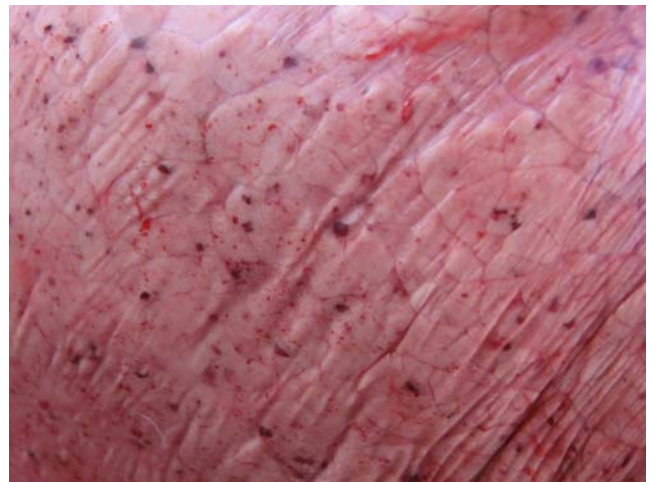


Fig. 3 Rubbery lung with ecchymotic and petechial hemorrhages

Results

On postmortem examination, gross lesions were limited to the heart, lungs, and liver. The heart was enlarged, globose, and had ventricular and atrial septal defects. The only outlet for the left ventricle was a large ventricular septal defect (VSD) located at 6 cm distance from the heart apex. The anomaly also involved both the membranous and muscular part of the interatrial septum (Fig. 1). The right ventricle was enlarged, markedly thickened with prominent papillary muscles. The left to right free wall ratio of two ventricles was 2.5:2. The aorta arose from the right ventricular infundibulum and the aortic valve was seen adjacent to pulmonary trunk (Fig. 2). Two valvular hematomas or hematocysts were observed near the edge of the right atrioventricular valve. The lungs were rubbery with

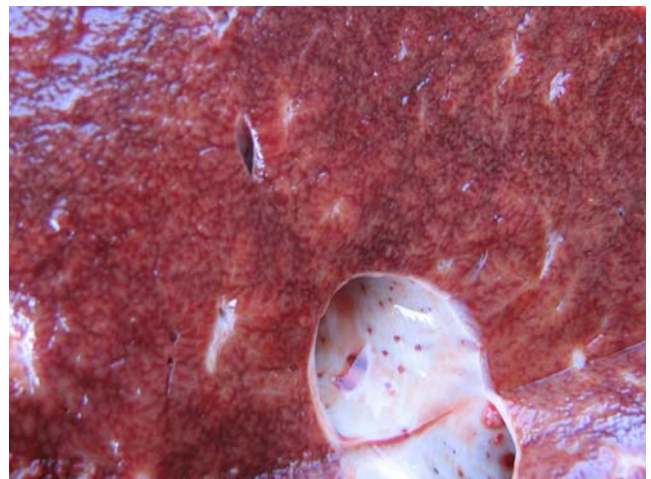


Fig. 4 Cut surface of the liver. Note accentuation of the normal lobular pattern

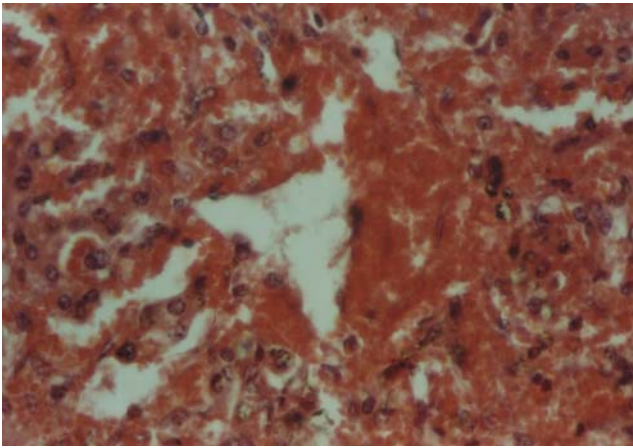


Fig. 5 Liver, note the accumulation of red blood cells around central vein and the absence of hepatocytes (hematoxylin and eosin, $\times 528$)

ecchymotic and petechial hemorrhage and did not collapse after removing from thoracic cavity (Fig. 3). Enhanced lobular pattern was evident on both the capsular and cut surfaces of the liver (Fig. 4). The postmortem findings confirmed the diagnosis of DORV.

Histopathological examination of the lungs revealed thickening of alveolar septa, hemorrhages, and infiltration of hemosiderophages within alveoli. Periportal hepatocellular fatty changes, substitution of centrilobular and midzonal hepatocytes by red blood cells (Fig. 5), and dilation of midzonal and periportal sinusoids were also seen in the liver.

Discussion

The definition of DORV remains controversial. According to Anderson et al., all of one great artery and 50% or more of the other artery must arise from the right ventricle to qualify for a diagnosis of DORV (Dharmapuram et al. 2006). Anatomic variations of DORV are classified according to the position of the great arteries in relation to each other, the relationship between a VSD and the great arteries, and the presence and degree of pulmonary stenosis (Prosek et al. 2005). Based on the relationship between the VSD and the blood vessels, there are four subcategories including DORV with subaortic VSD, if the VSD is right under the aorta; DORV with subpulmonary VSD, if it lies under the pulmonary artery; DORV with doubly committed VSD, if the VSD is under both the arteries; and finally, DORV with noncommitted VSD that the VSD is remote from the arteries and blood mixes in the right ventricle (Wilson et al. 1985).

We had some difficulty in classifying the VSD as doubly committed or noncommitted because of the large VSD. Most cases of DORV have a VSD.

DORV with an intact interventricular septum is rare in animals but has been reported in cattle and pigs. The presence of an VSD allows for the adequate egress of oxygenated blood from the left ventricle which is necessary for survival (Wilson et al. 1985).

In this case, the pulmonary lesions may be resulted due to pulmonary hypertension because pulmonary circulation is often exposed to very high pressure and increased blood flow in DORV cases that has additional effect on the developing of right side heart failure.

In the present report, the enhanced lobular pattern of liver or nutmeg liver may be caused by right side heart failure and hypoxemia. Nutmeg liver is not a specific finding and may be associated with zonal hepatocellular degeneration or necrosis, passive congestion, and diffuse cellular infiltration within the liver (Cullen and MacLachlan 2001).

The right ventricle was enlarged and markedly thickened with a left to right free wall ratio of 2.5:2 in the affected calf, in contrast to the normal 3:1 (McKenna et al. 2003). These findings are secondary to the cardiac congenital anomalies.

To our knowledge, this particular combination of cardiac defects has not been previously described in domestic animals and the pathological lesions observed in the calf may be resulted as a sequel to left–right blood shunting and heart failure.

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