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Veterinarians at the University of Pennsylvania School of Veterinary Medicine recently corrected a congenital defect in a calf. "Oreo, a black and white Holstein-Friesian calf, was admitted comatose to the George D. Widener Hospital for Large Animals at the New Bolton Center campus," said Dr. Johanna Reimer, resident in medicine. "The calf was otherwise normal in size and weight, and the only previous illness occurred three days prior to admission." The 10-week-old calf presented quite a diagnostic challenge, and it was treated ultimately not only by New Bolton Center clinicians but also by clinicians from VHUP and from Children's Hospital in Philadelphia.

On admission, a tentative diagnosis of viral encephalitis was made. The calf was treated and within two hours it stood up, but was uncoordinated in the hindquarters and dragged its rear legs. Over the next few days it improved, although it did exhibit intermittent episodes of depression, stupor, grinding of teeth, and tenesmus.

Sixteen days after hospitalization, the calf appeared normal but "a few days later it suddenly became ataxic again, exhibited tenesmus and was depressed," said Dr. Reimer. "We had previously monitored routine liver enzyme activity, and it had been normal, but in view of the recurring clinical signs we had to reconsider a diagnosis of encephalopathy, a brain disorder caused by malfunction of the liver. More tests were performed and it was found that the blood ammonia level and serum bile contents were very elevated. In view of these results, a tentative diagnosis of a portosystemic shunt (a venous shunt between the hepatic vein and the portal vein which diverts blood around the liver before detoxification) was made."

A liver biopsy was performed and no abnormalities were found. The next diagnostic tool employed was ultrasonography which revealed a shunt vessel between the portal vein and the caudal vena cava, compatible with patent ductus venosus. "In the fetus, the portal vein and the vena cava are connected by a blood vessel," said Dr. Reimer. "This bypasses the liver, but normally it closes early in life. If closure does not occur, substances such as ammonia and bile are not filtered from the blood by the liver and the animal becomes ill and dies. The defect has been diagnosed in dogs, cats, and one other calf."

Further tests were needed to determine the extent and location of the shunt. While arrangements were made to have these tests performed at VHUP, the calf was maintained on a low protein diet. It appeared normal, although its blood ammonia level was elevated. At VHUP, mesenteric portography was performed. "The animal was anesthetized and an incision was made in the right flank," said Dr. Reimer. "The liver was

normal in size and appearance. A catheter, inserted into an intestinal vein, was passed into the portal vein. Contrast material was injected and radiographs were taken as the material entered the enlarged portal vein and then went into the caudal vena cava through a patent ductus venosus. The diagnosis of a patent ductus venosus was confirmed."

The calf was maintained on a low protein diet with small frequent feedings while clinicians tried to determine a course of treatment. Occasional episodes of depression, inappetence, bruxism and tenesmus



Patent ductus venosus.

occurred, but these resolved spontaneously within one to three days. A pediatric specialist with an interest in congenital defects was consulted. Dr. Henry Wagner, professor of pediatrics at Children's Hospital, Philadelphia, agreed to assist in an attempt to close the shunt with an umbrella-type device. Three months after the calf had been admitted, it was again anesthetized for surgery. A catheter was passed into the ductus venosus with the aid of fluoroscopy and ultrasonography. Another catheter containing the occlusion device, was passed through a jugular vein into the caudal vena cava to the opening of the ductus venosus. The two catheters were joined together to enable the catheter containing the umbrella to be pulled into the ductus venosus. The umbrella-like vessel occluder with hooks to secure it in place was opened and attached to the shunt vessel wall. Partial occlusion occurred; the securing hooks pulled free from a part of the vessel wall.

The blood ammonia levels and bile acids remained elevated but were improved. Blood still flowed through the ductus venosus toward the caudal vena cava. The calf continued to grow, although after six months of age, its height and weight began to fall below expected values. At this point, because the animal weighed over 500 pounds, fluoroscopy and radiographic contrast studies could not be performed with available equipment. Surgery was performed by

Dr. William Donawick, Mark Whittier and Lila Griswold Allam Professor of Surgery, to assess the situation and to attempt to close the shunt with ligatures. He was assisted by Dr. Henry Wagner and by Dr. John Stremple from the University of Pittsburgh School of Medicine. A catheter was inserted into the ductus venosus to facilitate identification of the shunt.

The surgeons examined the liver and found it small but normal. The ductus venosus was close to the surface of the organ and was only partially encircled by liver

tissue. With luck, it appeared possible to encircle the shunt with ligatures and tie off the ductus. Ultrasonography during the surgery confirmed that complete occlusion had been achieved.

The calf recovered, and three days after the operation the blood ammonia level was close to normal. The animal was gradually returned to a normal diet. The calf is now back home and expected to live a normal life. Because this type of congenital defect appears to be uncommon, it is unlikely that it is an inheritable condition.

"The incidence of such anomalies in the bovine is not known," said Dr. Reimer. "They may be difficult to diagnose clinically or at post mortem; liver enzymes may be normal and clinical signs may vary. Portosystemic shunts should be considered in calves with vague neurologic signs, tenesmus, depression or stunted growth once other common causes of neurologic disease and poor growth have been ruled out." She pointed out that the ability to perform ultrasonography and contrast radiography is essential when surgical correction of portosystemic shunts is attempted. "Also, we were fortunate in that the ductus venosus was located close to the surface, minimizing surgical damage to the liver."

She explained that the failure of the occlusion device was probably due to its inadequate dimensions. One must remember that such devices are designed for humans and that blood vessels in large animals are bigger. Although the diameter of the calf's shunt was determined to be at least 2.0 cm by ultrasonographic techniques, an attempt was made to utilize the device as it might have been sufficient. While this technique did not work for Oreo, the ligation technique was successful and the clinicians at New Bolton Center were able to



Patent ductus venosus after ligation.

demonstrate that such defects can be corrected in large animals.

The cooperation of clinicians from different hospitals at Penn saved Oreo's life, demonstrating that veterinary medicine and human medicine are not that far apart. The clinicians from VHUP were Drs. Jeffrey Wortman and Gert Niebauer. In addition to Dr. Reimer and Dr. Donawick from New Bolton Center Campus, Drs. Virginia Reef and Thomas Divers also helped Oreo.



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