'Blue eyes' in newborn calves associated with bluetongue infection

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FIG 1: Clinical presentation of a one-week-old calf with 'blue eyes' as a clinical sign of bluetongue virus infection. Photo: Olst-Wijhe private veterinary practice

EYE abnormalities are commonly diagnosed in bovine practice. Most cases are associated with bovine keratoconjunctivitis. This disorder is encountered in both dairy and beef calves, and in adult dairy cows. *Moraxella bovis* is most frequently isolated as the causal organism of bovine keratoconjunctivitis in the Netherlands (Holzhauer and others 2004). Another abnormality is disturbed vision related to bovine viral diarrhoea virus (BVDV) infection during pregnancy resulting in inflammatory damage to the retina and optic nerve of the fetus. The diagnosis is based on observation of signs consistent with visual disturbances and a positive BVDV test (Riis 2008).

Since the year 2000, the western European dairy industry has experienced outbreaks of a congenital lens cataract defect in calves. In some cases, these lesions have been presumed to be related to intrauterine BVDV infections (Kahrs and others 1970). However, they have also been seen in certified BVDV-free herds. These lesions are now thought to be related to a disturbance during organogenesis in newborn calves (Dutch Animal Health Service [GD], unpublished observations).

Since October 2007, approximately 30 herdsmen and/or veterinary practitioners have approached GD regarding a new or unknown corneal abnormality in newborn calves (less than three days of age). In these cases, whitening of the corneas was demonstrated in the absence of a positive fluorescein test (Fig 1).

A case-control study was performed on nine dairy herds and one herd with beef calves, in which an eye abnormality had been reported, to establish whether there was a link between corneal abnormality, BVDV and the recent introduction of bluetongue in these herds. The herds were visited in December 2007, when the calves were examined clinically and an eye swab was taken for a bacteriological investigation of the presence of *Moraxella bovis* and *Mycoplasma bovis*. Blood samples were taken from the affected calves, their dams and at least one randomly selected herdmate that had been born on the same day or within a period of 10 days before or after the birth of the affected calf, to investigate the relationship between the defect and BVDV in non-BVDV-certified herds (checked for persistent infection and monitored serologically twice a year), and to determine whether there was an association between the defect and bluetongue infection. In some cases a complete set of samples could not be taken because herdmates had already been sold when the herd was visited (herds 1 and 3); in herd 5, the dam had been sold; and herd 10 consisted only of beef calves, with no dams present. Antibodies to bluetongue virus were tested for using ELISA, and viruses using PCR. In cases where the calf had died or had been culled for other reasons, it was sent to GD for pathological investigation. Only two calves were sent to the laboratory: the affected calf in herd 6, which was euthanased because of a failure to grow, and one of the beef calves in herd 10, which died having shown diarrhoea at two months of age (no causal agent was found). The association of corneal oedema with the bluetongue PCR test results was evaluated using Fisher's exact test.

Most calves demonstrated healthy development and growth, but five calves had a lighter weight at birth (approximately 25 kg) and 10 calves grew more slowly than was expected. The calves with low birthweight were in herds 2, 4, 6, 7 and 9; based on information provided by the herdsmen, low birthweight was associated with corneal oedema.

The calves were less than 30 days old at the time of clinical inspection. The affected calves' eyes had a deviated shape and were more cranial than normal, and had a blue-white corneal shimmer and slight conjunctivitis. None of the calves demonstrated blepharospasm and the investigation with fluorescein was negative in all cases, indicating an intact corneal epithelium. Some vision was still present, since the calves behaved normally. Based information provided by the herdsmen on the date of confirmation of bluetongue virus infection at the Dutch National Reference Laboratory in Lelystad, the Netherlands, all dairy cows from which affected calves were born were in their last third of pregnancy at the time when bluetongue was introduced into the herd.

The laboratory investigation of eye swabs for both *Moraxella* and *Mycoplasma* species was negative. Six calves with clinical signs of 'blue eyes' (and their herdmates) were born in non-BVDV-certified herds. The other three dairy herds were considered not to have BVDV circulating on the basis of negative serological tests carried out more than three weeks after the calves' birth. Two calves tested negative for BVDV at postmortem examination and serologically, one calf tested positive for BVDV antibodies but negative by PCR (Table 1).

The PCR test for bluetongue was positive in nine of 10 calves with corneal oedema (four calves with corneal oedema were not tested for bluetongue using PCR) and in one of five control calves without corneal oedema. The relationship between the result of the PCR for bluetongue and the presence of corneal oedema was statistically significant ($P=0\cdot02$). In cases where PCR was positive for bluetongue, the dams were also positive for bluetongue by PCR and serological testing. Pathological investigations of two affected calves demonstrated local infiltration of blood vessels in the periphery and infiltration of neutrophils in the centre of the cornea. No other lesions were found.

The persistence of the corneal defect was evaluated by a telephone call when the calves were five to six months old. On the basis of this information, only a small corneal white spot was still present in eight of the affected calves, while vision and health were reported as normal.

The presented lesion is reminiscent of the so-called 'blue-eye phenomenon' in dogs, which is a temporary type III hypersensitivity reaction associated with canine adenovirus type 1 (infectious canine hepatitis) infection or vaccination with a live virus vaccine (Curtis and Barnett 1983). Nine of 10 calves with eye abnormalities in the present study were positive by PCR for bluetongue virus, which sug-

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TABLE 1: Relationship between the presence of oedema and laboratory test results for infection with bluetongue virus and bovine viral diarrhoea virus (BVDV) in 27 cattle from 10 herds in which at least one calf per herd presented with an eye abnormality

Herd	Dam/calf	Date of birth	Date bluetongue was introduced	Oedema	Bluetongue ELISA	Bluetongue virus PCR	BVDV
1 (dairy)	Dam		Sept 07	–	+	+	–
	Calf	01/10/07		+	+	+	
2 (dairy)	Dam		July 07	–	NA	NA	–
	Calf	03/09/07		+	NA	NA	
	Calf	30/08/07		+	NA	NA	
3 (dairy)	Dam		July 07	–	+	+	Herd certified free
	Calf	01/10/07		+	+	+	
4 (dairy)	Dam		July 07	–	+	NA	Herd certified free
	Calf	01/10/07		+	+	NA	
	Calf	03/10/07		+	+	NA	
5 (dairy)	Calf	15/10/07	Sept 07	–	–	–	Herd certified free
	Calf	16/10/07		+	+	+	
6 (dairy)	Dam		Aug 07	–	+	+	Herd certified free
	Calf	09/10/07		+	+	+	
	Calf	03/10/07		–	+	+	
7 (dairy)	Dam		Aug 07	–	+	+	Herd certified free
	Calf	27/09/07		+	+	+	
	Calf	26/09/07		–	+	–	
8 (dairy)	Dam		Sept 07	–	+	+	–
	Calf	21/10/07		+	NA	+	
	Calf	22/10/07		–	–	–	
9 (dairy)	Dam		Aug 07	–	–	–	Herd certified free
	Calf	01/12/07		+	–	–	
	Calf	02/01/07		–	–	–	
10 (beef)	Calf	29/08/07	Aug 07	+	NA	+	+
	Calf	28/08/07		+	NA	+	+
	Calf	31/08/07		+	NA	+	–

NA Test not done, + Positive, – Negative

gests that the oedema was caused by intrauterine bluetongue infection, followed by a passive colostral immunisation during the first day postpartum. After the antibody intake, antigen-antibody complexes may have been deposited on the predilection sites of the virus. This virus has preferences for epitheliotrophic organs, such as the eyes and kidneys, and deposits may be expected here, attracting neutrophils and several enzymes, which can result in whitening of the corneal epithelium (Tizard 2000).

In the literature, there is one comparable description of a congenital corneal defect known as keratitis posterior (Stöber 2002). However, this could be excluded in the present study, based on the presence of individual affected animals in the herds, with closely related calves that were born during the past years without the presence of 'blue eyes'. The lesion also differed from another typical congenital lesion in dairy calves, lens cataract, where the whitening is present in the lens (Glanz and others 2006). The differences in clinical courses in the calves, such as a slow growth rate in 10 of them, might have been due to the simultaneous presence of deposits of antigen-antibody complexes in other organs such as the kidneys. Further histopathological investigation should pay special attention to this, because such internal deposits might easily be missed during normal routine diagnosis.

Herdsmen and local practitioners should be aware of complications that may be associated with a modified live vaccine bluetongue virus, since complications have been seen after vaccinating dogs with live canine adenovirus type 1 vaccine (Curtis and Barnett 1983).

The low incidence of eye abnormalities in cattle associated with bluetongue (25 to 30 reports in the Netherlands, usually with only one calf per reporting herd) is in line with other results from the Netherlands and Belgium, indicating a low percentage (16 per cent) of intrauterine bluetongue transmissions (Van Wuyckhuise and others 2008).

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