Sperm tail-stump defect in a Holstein bull

S. G. Revell, N. Cranfield, W. Cooley

THE sperm tail-stump defect has been reported in Holstein bulls in Canada (Coubrough and Barker 1964) and Denmark (Blom 1976), and also in Charolais (Williams 1987), Ayrshire (Vierula and others 1983, 1987, Arriola and others 1985, Foote and others 1992) and polled Hereford (Peet and Mullins 1991) bulls. This short communication describes a case in a Holstein bull, which was investigated by using light microscopy and both transmission electron microscopy (TEM) and scanning electron microscopy (SEM).

The bull was born to a surrogate dam subsequent to embryo transfer, at an artificial insemination (AI) nucleus herd-associated embryo transfer unit. At 68 days of age, it was clinically examined, and it was moved to an AI bull-rearing unit at 109 days of age. Its rearing was uneventful. At 11 months old, the bull calf underwent the statutory tests for AI licensing, together with the tests for leptospirosis and bovine viral diarrhoea virus antibody required by the breeding company. It was moved to the AI freezing unit at 13 months of age.

Semen was collected from the bull on 24 occasions over 12 weeks by using an artificial vagina. The volume of the ejaculate was measured by weight and the sperm concentration was estimated photometrically. Sperm motility was assessed by examination of semen both directly and after dilution in warmed normal saline, using a microscope with a heated stage and negative phase contrast optics, at a magnification of x 100.

Semen for morphological examination by light microscopy was prepared by staining in warmed eosin (1-6 per cent) and nigrosin (10 per cent) in 2.9 per cent sodium citrate for five minutes, after which an air-dried smear was prepared. Semen fixed in buffered formal saline was used for examination by differential interference contrast microscopy. These samples were examined at a magnification of x 1000.

Semen for electron microscopy was fixed in warmed 3 per cent glutaraldehyde in 0·1M phosphate buffer, 0·1 ml of raw semen being added to 2 ml of the fixative. For TEM, the sperm were immediately centrifuged to form a pellet; for SEM, they were left in suspension. The samples for TEM were then fixed in osmium tetroxide, embedded in Araldite (Agar Scientific), treated with uranyl acetate and lead citrate, and examined using a Philips CM10 instrument at 80 kV. For SEM, fixed sperm on coverslips were postfixed with osmium tetroxide, dehydrated and critical point dried using liquid carbon dioxide. The dried specimens were attached to aluminium stubs using silver conductive paint, sputter-coated with gold and examined using a Stereoscan S250 instrument (Cambridge Instruments) at 10 to 20 kV.

The mean ejaculate volume was 3·5 ml (range 1·6 to 5·8 ml) and the concentration of sperm ranged from 100 to 200 million/ml. No motility was observed in any of the samples. Examination of the bull at 19 months of age revealed no abnormalities apart from a slight softness of the testes. The scrotal circumference was 37 cm.

The forms of the sperm defect, as observed by light microscopy, were enlarged, droplet-like structures attached to the base of the head (56 per cent), short, irregularly coiled tails (15·5 per cent) and straight, short (up to 50 per cent of normal length) tail-like structures (28·5 per cent). These three defect types are illustrated as scanning electron micrographs in Figs 1a, b, and c, respectively. All of the sperm examined microscopically exhibited one of these forms. The straight forms showed no evidence of a properly formed mid-piece or Jensen's ring. The width of the tail varied irregularly, with a tendency to be larger at the distal end. 'Coiled' tails appeared similar, with the end of the tail deflected back on itself.

TEM revealed the droplet-like forms to contain few organised structures. Implantation plates were seen in some, and all showed membranous material, some mitochondria, elements of fibrous sheath, individual fibrils and some cross-sections of axoneme (Fig 2). None of the axonemes showed the normal, precise tubular, fibre and sheath construction.

The bull was fully under the control of the Genus breeding programme from birth to death. Its records showed that it suffered no significant illness and that it developed as expected for its breed and type. The scrotal circumference of 37 cm was satisfactory for a 19-month-old Holstein. The average for this breed on entry to an AI programme at 12 months is 32 cm (A. J. Taylor, personal communication). Williams (1987) stated that bulls with the same sperm defects as the present case were physically normal on examination.
The ultrastructural findings resembled those reported by Vierula and others (1983), although the droplet-like structures in the present study contained fewer of the identifiable elements and more amorphous granular material.

A common ancestor was found on both sides of the pedigrees of two affected bulls studied by Foote and others (1992), which was considered to be a strong indication that the condition is inherited. In the present study, no common ancestor of the bull’s sire and dam was found in five generations. The constant observation, recording and testing of this bull revealed no problem of any kind in its rearing which may account for the abnormal spermatogenesis, and a genetic basis is therefore likely. The T locus affects axoneme development in mice (Yanagisawa 1965), and may be the source of this defect in cattle. Unfortunately, resources were not available for cytogenic study of the present case. The condition is self-limiting due to sterility, and the incidence of carriers appears to be low, with few cases being reported, spread over a variety of breeds.

ACKNOWLEDGEMENTS

The authors are indebted to Professor Paul Watson for his comments on the electron micrographs.

References


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Veterinary Record 2003 153: 242-243
doi: 10.1136/vr.153.8.242

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