DAG-LIKE SPERM DEFECT AND ACROSOME ABNORMALITIES INDICATING HEREDITARY SPERM DEFECTS IN A JERSEY BULL

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Received : 18.07.14 Accepted : 06.01.15

ABSTRACT

A study was undertaken on the consistent occurrence of sperm abnormalities in a Jersey bull maintained in an organized frozen semen production station. Data on semen collections and a representative ejaculate from the bull in question were collected to evaluate the semen characteristics. From the records it was observed that 74.5% of the ejaculates were rejected as fresh semen for poor semen quality especially in sperm morphology. The representative semen sample also revealed low sperm concentration, poor sperm motility and sperm abnormalities up to 82.4%, of which 65.2% of the spermatozoa showed 'Dag-like' defect. Majority of the spermatozoa in the ejaculate also showed abnormal acrosome status (75.1%). Consistent occurrence of high proportion of 'Dag-like' sperm defect and acrosome abnormalities suggested a genetic cause.

Keywords: Jersey bull, Dag-like sperm defect, Acrosome defects, Genetic sperm defects

Morphology of spermatozoa is species-specific in mammals and genetically controlled. The relationship between increased morphological abnormalities of spermatozoa with reduced reproductive efficiency has been well documented in many species in general and particularly in bulls. High incidence of abnormal spermatozoa could be an indicator of genetic basis (Hafez, 1987) although sperm defects may also be due to environmental reasons.

Dag defect has been identified as a heritable sperm defect and proven to be associated with impaired fertility in bulls. Although dag defect was first identified in Danish Jersey bulls later similar defects were reported in other breeds like Hereford bulls (Andersen *et al.*, 1996) and other species like stallion (Hellander *et al.*, 1991), buffalo (Ribeiro and Vale, 2007), dog (Rota *et al.*, 2008), cat (Bablin Villaverde *et al.*, 2013) etc. Spermatozoa must have the acrosome cap intact during its travel in the female reproductive tract and should undergo acrosome reaction at appropriate time to release the acrosome enzymes which facilitate the sperm to penetrate the zona-pellucida of the egg during fertilization. Therefore acrosome integrity is one of the important indicators of fertility (Neild *et al.*, 2005; Esteves *et al.*, 2007).

The present study was on a Jersey AI bull, aged 42 months, consistently producing spermatozoa with dag-like defects and high proportion of abnormal acrosome. The bull was in semen collection programme since October 2013 and till the time of the study 47 ejaculates were taken using artificial vagina. The ejaculates were evaluated for semen characteristics namely ejaculate volume, sperm concentration, sperm motility and sperm morphology by conventional methods. Morphological evaluation was done on sperm slides stained with 3% Rose Bengal by counting 200 spermatozoa. A representative ejaculate was taken from the bull and evaluated for all the semen characteristics enumerated earlier. Furthermore, acrosome integrity was assessed using Giemsa staining procedure (Hancock, 1953) with slight modifications. The acrosome morphology was

classified (Blom, 1972; Lunstra and Echternkamp, 1982; Chenoweth, 2005) as normal (sperm with tightly adhered intact acrosome with a smooth surface and periphery and a distinct, uniformely shaped apical ridge) ruffled (sperm with irregular staining acrosome leading to a wrinkled or ruffled appearance), incomplete (irregular margin, giving the appearance that part of the acrosome was missing or incomplete) and completely lost (complete loss of acrosome cap indicated by uniform light staining intensity throughout the spermatozoon head).

From the records on semen collection, it was observed that 74.5% of the ejaculates were rejected as fresh semen for poor semen quality. The progressive sperm motility was very poor (39.6%) and the sperm abnormality (30%) was above the permissible level of 20%. The representative sample collected for the study also had very poor quality in all semen characteristics studied (Table 1).

Sperm concentration and motility were very low with 444 million per ml and <10% respectively. Large proportion of spermatozoa (82.4%) in the ejaculate had abnormal morphology. Dag-like defect was seen in 65.2% of spermatozoa (Figure 1). Acrosome morphology of the tested ejaculate from the affected bull showed that 75.1% of the spermatozoa had defective acrosome. While 34.8% of sperm cells exhibited ruffled acrosome, the incomplete acrosome and spermatozoa with completely lost acrosome were 17.9% and 22.4% respectively (Figure 2).

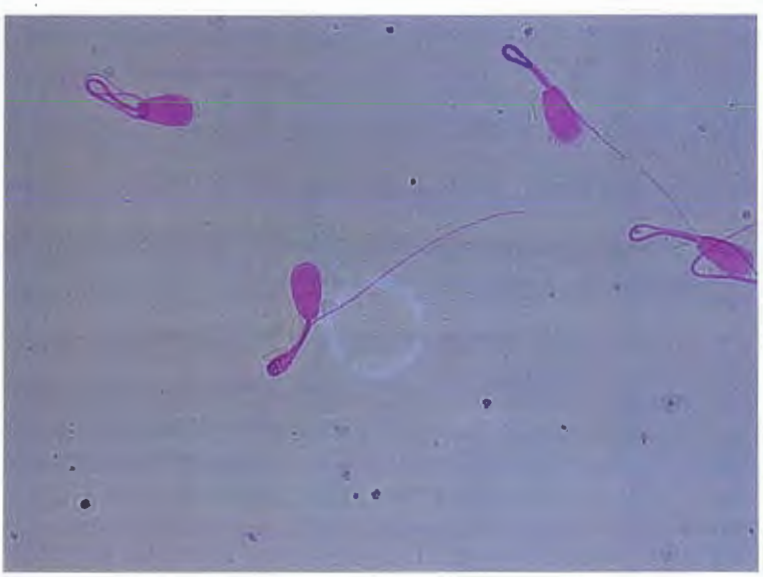
Large proportion of spermatozoa in the ejaculate from the affected bull showed strong folding of the tail backward forming a loop at the distal part of the mid-piece where it is bent. Such kind of morphology in spermatozoa was described as 'Dag defect' and the inheritance of the defect was due to autosomal recessive factor (Chenoweth, 2005). Most of the spermatozoa showing this kind of defect have not retained the cytoplasmic droplet, while a small proportion of sperm cells have exhibited the presence of distal cytoplasmic droplet. The hereditary basis of the defect could not be ascertained in this study since the bull involved was purchased in calf-hood from another Jersey cattle breeding farm and the institution did not involve in semen production. Some environmental factors also could possibly produce dag like defect. However, the bull involved in this study was maintained in standardized management conditions and nutrition along with many other bulls for frozen semen production in which no such abnormality was detected, suggesting a genetic basis for the defect in the affected bull. The semen of the bull also had very high proportion of acrosome defects namely ruffled, incomplete and completely lost acrosome. High proportion of these defects in sperm cells may be a heritable defect (Chenoweth, 2005) and also strongly associated with fertility of the bull (Hough *et al.*, 2002).

To conclude, the consistent occurrence of dag-like sperm defect and acrosome abnormalities, in the ejaculates of the Jersey bull since inception may be due to impaired spermiogenesis, resulting possibly because of a genetic cause. The environmental cause of the abnormal morphology of the sperm could not be suspected as the other bulls maintained in the same environment and nutrition produced good quality semen for frozen semen production. No improvement on semen quality could be seen in the affected bull over time. Therefore, advice was given to eliminate the affected bull from the frozen semen production programme.

Table 1. Percentages of spermatozoa with different sperm abnormalities and acrosome defects in a representative ejaculate of the affected bull

Type of sperm defects	Percentages
Head Defects	
Detached heads	6.33
Macrocephalic heads	0.90
Pyriform heads	0.45
Mid piece defects (Dag-like defects)	
Strongly folded tail without retention of distal cytoplasmic droplet	57.5
Strongly folded tail with retention of distal cytoplasmic droplet	7.69
Tail defects	
Bent tail	8.60
Coiled tail	0.90
Overall sperm abnormalities	82.4
Acrosome defects	
Ruffled acrosome	34.8
Incomplete acrosome	7.90
Lost acrosome	22.4

Figure 1. Dag-like defect of folding of tail of spermatozoa with retention and without retention of cytoplasmic droplet



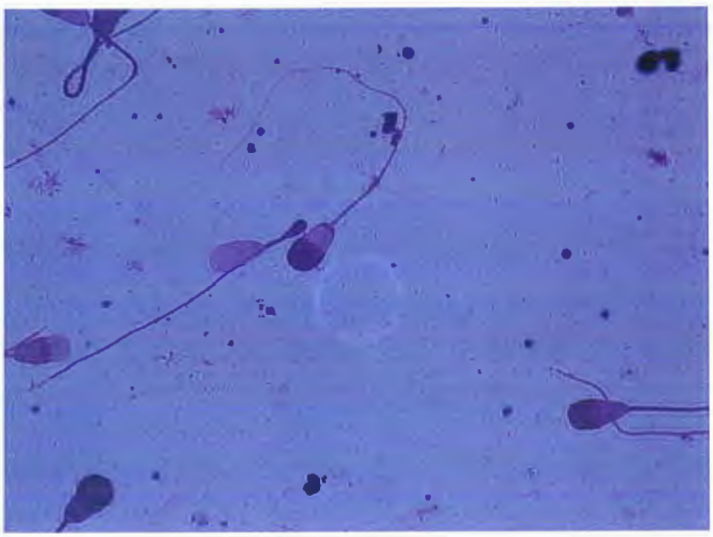


Figure 2. Spermatozoa with ruffled acrosome, incomplete acrosome and completely lost acrosome

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