Notes on Sperm Cell Morphology

Most of what we know about the effects of abnormal sperm on fertility in animals is derived from studies on bull sperm. However, the effects of sperm cell defects are probably similar regardless of the species involved. Sperm cell defects can be acquired (refer to VHM 222 notes “Diseases of the Reproductive Tract of the Male” for some of these causes) or inherited. Acquired defects are most common and are not always morphologically distinguishable from inherited defects. Sperm cell morphology must always be examined under oil immersion (≥1000X).

There are several systems for classifying sperm cell defects into broad categories. Primary defects are considered to originate in the testicles and secondary defects are considered to form in the epididymides. This system does not help one prognosticate effects on fertility. Another system divides defects into major and minor but this system has become outdated.

A more recent system looks at defects as being compensable or non-compensable. Compensable defects are those that are not transported to the oviducts and if they are, cannot fertilize oocytes. Examples of these are sperm with tail defects or acrosome abnormalities. Therefore, increasing sperm dosage to increase the number of normal sperm inseminated may result in normal fertility rates. Defective sperm that are capable of fertilizing oocytes are considered to be non-compensable because increasing the insemination dose does not alter the chance of an abnormal sperm uniting with the egg and producing a defective embryo. Non-compensable defects usually include certain abnormalities of the sperm nucleus.

It is preferable not to classify sperm cell defects into broad categories. Instead, the percentage of each sperm defect should be recorded and the prevalent defects should be considered in regard to their significance. Generally, >70% morphologically normal sperm are considered necessary for optimal fertility. However, a bull whose semen exhibits 30% midpiece defects resulting from a recent stressful event has a better long-term prognosis for fertility than a bull with 30% severe head defects resulting from a heritable condition.

Sperm cell defects are illustrated on the attached sheet. Good photographs and a brief description of the effects of individual defects are presented in the manual “Bull Breeding Soundness Evaluation” by Albert Barth. This manual is available in the library and at the bookstore. Some comments on common defects follow:

The heads of stallion sperm can vary somewhat in shape and size in the same ejaculate so determining what is abnormal can be a matter of judgement. In cattle,
moderately tapered or pyriform heads, or pinching at the base of the head (not shown in illustrations) can be normal for a particular bull when the great majority of cells in the ejaculate exhibit one of these characteristics. However, when these defects occur along with many normal-shaped heads, or when the defects are severe, they are considered to be abnormal. In cases such as this, there are usually other signs of abnormal spermatogenesis (other types of sperm cell defects) as well.

**Nuclear vacuoles** can go undetected unless one carefully examines the sperm heads in a good stain preparation under high magnification. Single apical vacuoles may not affect fertility. The proportion of cells affected by vacuolation may vary over a time.

**Detached heads** are often the result of senescence and generally don’t occur in high numbers. High numbers of these defects can indicate sperm cell accumulation in the cauda epididymides (rusty load), abnormal implantation of the tail, or even an artifact caused when the slide was made. The latter can be ruled out by observing live sperm for evidence of high numbers of detached heads.

The **knobbed acrosome defect** can be inherited. The beaded form of this defect may be more serious than the indented form.

Sperm with **tail defects** will have poor motility and some will swim backwards. Some of these defects such as a **bent principal piece** or **distal midpiece reflex** without an enclosed droplet can be caused by the hypotonic eosin-nigrosin stain that is commonly used, or by urine contamination. However, this is an uncommon occurrence. Slides stained with eosin-nigrosin should be dried quickly to reduce chances of staining artifact. Artifactual bending of the midpiece can be ruled out by comparing with observations of live sperm. This also applies to sperm with **bowed midpieces** (a rare true defect). Simple distal principal piece bends can be counted as normal.

**Abaxial tails** do not adversely affect fertility in bulls, stallions and boars, and probably in other species as well. The effect of sperm with accessory tails on fertility is unknown, but the defect may be inherited in bulls.

The **Dag defect** can be found in small numbers in many semen samples but a high percentage of these defects (e.g., 50% or more) indicates recessive inheritance of the problem.

**Proximal droplets** are an indication of abnormal testicular or epididymal function, especially if they occur in large numbers. **Distal cytoplasmic droplets** do not appear
to affect fertility.

(GFR - May 2003)