Understanding Bull Breeding Soundness Evaluations

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Introduction

The purpose of a breeding soundness evaluation is to assess the breeding potential of a bull at a given point in time. This includes a history and general physical examination (eyes, legs, feet, etc.) along with careful examination of the reproductive tract and semen quality. Semen evaluation includes observation of semen volume and concentration, motility (vigor), and sperm cell shape under magnification. The information from the exam is generally reported using a form such as the one adopted by the Western Canadian Association of Bovine Practitioners (page 15) which insures that all information relevant to the exam is recorded.

It is estimated that 1 of every 5 bulls in an unselected population have inadequate semen quality and/or physical soundness (1,2,3). This does not mean these bulls are infertile but suggests that they are likely to have reduced fertility. In addition to physical problems, numerous studies have identified factors that affect semen quality. These include age, genetics, season (photoperiod) and weather (3), poor or excessive body condition (3,6), stress (5) abnormal scrotal heat regulation (7) and testicle size (3,8).

The intent of this guide is to outline some of the common semen and physical defects that bull owners may encounter. Although there are many known sperm defects, only the most common have been included along with some of the information available regarding the potential outcome for a bull with these sperm abnormalities. In many situations the cause of poor semen quality cannot be determined. Although a prognosis can often be given for bulls with certain sperm defects, there can never be a guarantee that a bull will produce satisfactory semen within a given time frame. It must be stressed that there is no way to predict with 100% confidence what the outcome will be for a bull with a specific defect and repeat testing is your only assurance that a bull is producing satisfactory semen.

Much of the information contained in this booklet comes from “Bull Breeding Soundness Evaluation” (9) and “Abnormal Morphology of Bovine Spermatozoa” (10). The sperm cell photomicrographs are compliments of Dr. Albert Barth (Western College of Veterinary Medicine) and we extend our thanks for allowing us to use them in this document.
Anatomy

A brief outline of the anatomy of the reproductive tract is helpful in understanding some of the problems encountered in bulls examined for breeding soundness. On the following page is a photograph showing the entire reproductive tract of the bull followed by photographs of the testicle and epididymis from several views.

The epididymis is the duct system that gathers the sperm cells produced in the testicle and provides a site for storage and maturation of sperm (page 5). It is divided into 3 segments: head, body and tail. Each segment can be palpated during the physical examination of the testicles. The head is a wide flattened structure positioned toward the top and front of the testicle and receives the duct system that carries sperm cells from the testicle. The head then narrows into the body - a flattened tube that travels down the inner side of the testicle to the bottom where it forms the tail - an enlarged area that acts as a storage site and the location where sperm cells mature. Infection of the epididymis, particularly the tail, is seen occasionally as are developmental defects where it may be absent or underdeveloped (hypoplastic). This may result in obstruction of sperm movement from that testicle or may contribute to sperm defects by altering the chemical environment of the epididymis. The tail of the epididymis makes a hairpin turn, continuing back upward as a smaller diameter tube called the deferent duct. The deferent duct travels back up along the inside surface of the testicle and continues up to join the urethra just past the bladder near the site where the seminal vesicles join with the urethra. During ejaculation the sperm cells are mixed with seminal fluid produced by the seminal vesicles which increases the volume and provides nutrients for the sperm cells. The seminal vesicles can be readily palpated during a rectal examination and assessed for size, symmetry and consistency. Swollen or hard vesicles may indicate an infection - a common finding which if still active may result in pus in the semen sample. At the time of sample collection the penis can be examined for abnormalities such as warts or a persistent frenulum - also referred to as a tie (page 13).
Reproductive tract of the bull

- Seminal vesicle
- Bladder
- Ductus deferens
- Testicle
- Penis
- tail of epididymis
**Testicle anatomy**

- view from behind

Head of epididymis

Tail of epididymis

- view of right testicle turned sideways

Deferent duct

Body of epididymis

- view of left testicle from front showing head more clearly

Head

Tail
**Semen Morphology**

The ability of the sperm cell to travel to and fertilize the egg are essential components of fertility and therefore morphology (sperm cell shape) is given substantial weighting in a reproductive exam. The following six pages show photomicrographs of a number of common sperm morphology defects along with a brief description of the defect, possible causes and prognosis for improvement. Semen morphology is assessed by counting a minimum of 100 cells under 1000x magnification and determining the number of each defect present. A minimum score of 70% normal cells is required to receive a satisfactory rating. Defects involving the tail (bent tails, coiled tails) are thought to be mostly filtered out along the female reproductive tract before they reach the oviduct, reducing competition with normal cells for fertilization. On the other hand, sperm cells with head defects (the head contains the nucleus which carries the DNA) may reach the egg and compete with normal cells to initiate fertilization. Once a cell with a nuclear defect initiates fertilization, it blocks other cells from entering the egg and may result in a non-viable embryo. Therefore, of the 30% total allowable defects, tail defects such as proximal droplets or bent tails can be as high as 25% while defects that have a more serious effect on fertility such as pyriform heads have a 20% limit.

The effect of age and season on semen morphology cannot be overstated. Many young bulls (11 -15 months) produce samples with a high percentage of proximal droplets which generally resolve with age. As well, research has shown that semen morphology tends to be poorest in January and February and gradually improves through June (3). This may be caused by a combination of factors which include photoperiod (length of daylight), cold stress, body condition or nutritional stress. The bent tail defect (also called distal midpiece reflex) is very common following periods of severe cold weather. As many as 50% of bulls tested shortly after periods of severe cold may fail a semen evaluation as a result of this defect. This leads to great frustration on the part of both owner and veterinarian. Most of these bulls (90% +) improve within several weeks. However, a small percentage do not improve and therefore retesting is essential to identify these. Recognizing that age and weather play a significant role in semen quality can be helpful in selecting an appropriate time for scheduling breeding soundness examinations.
Loose heads or detached heads

It is common to find a few detached heads in a sample of a normal bull. This defect may be seen in high numbers in bulls that have testicular abnormalities or inflammation of the epididymis or seminal vesicles. Some bulls tested in early spring may have a high percentage of detached heads on the first one or two samples collected and then decease to normal levels with successive ejaculation. This is believed to occur when stored aged sperm cells break apart in the epididymis following a prolonged period of breeding inactivity.
The tail is folded backward, forming a loop at the point where it is bent. The defect appears to develop while the sperm cells are stored in the epididymal tail and is believed to be caused by exposure of the sperm to abnormal secretions in the epididymis. These secretions are under the influence of the hormone testosterone and any stressors such as weather or a fever may affect testosterone production, resulting in this defect. This is a very common defect seen in bulls tested in January through April (3) and may be particularly prevalent during or following periods of cold weather. Bulls with this defect have a good prognosis for improving within a few weeks. However, some bulls do not improve. There is no reliable method of determining which bulls will recover and therefore repeated testing is warranted.
**Proximal droplets**

Proximal droplets are part of the normal development process of sperm cells and are normally lost once the cells pass through the epididymis. When present in high numbers in samples from young bulls (less than 16 months of age) they generally suggest immaturity and in most cases disappear within a month. When this defect is seen in older bulls (>18 months) or in combination with other defects such as pyriform heads it is more likely to indicate some sort of insult to the sperm development process. Under these circumstances the prognosis is less clear.

**Distal droplets**

Most sperm cells stored in the epididymal tail have a distal droplet which is part of normal sperm development. As the sperm cells mix with seminal fluids at ejaculation the droplet is shed. In situations where the droplet is not shed this defect will be seen in the sample. This is not considered to affect fertility and therefore bulls with this defect but otherwise normal sperm should be considered satisfactory.
**Pyriform heads**

With this defect the sperm cell head is pear shaped, affecting the cell nucleus and therefore the fertilizing capability or the viability of the resulting embryo. Pyriform heads arise within the testicle during sperm development as a result of disturbance of heat regulation or through a hormonal disturbance. Events such as fever, inflammation from frostbite, or excess scrotal fat may all contribute to abnormal heat regulation in the testicle. Stresses such as chronic pain, show circuit stress or temperature extremes may also contribute to the hormonal imbalances that can lead to these defects.

Prognosis for recovery is difficult to predict. Since it takes approximately 60 days for sperm cells to develop, repeat testing at 1-2 month intervals may aid in assessing recovery. If the cause of the problem is known and can be corrected, recovery may be anticipated in time. Where the cause is unknown, some evidence suggests that the likelihood of recovery is related to the severity of the problem; i.e. bulls with a high percentage of this defect may be less likely to recover.

**Vacuoles**

Crater like defects on the head of the sperm cell. When arranged in a ring around the lower third of the head they are referred to as *Diadems*. The appearance of vacuoles appears to be related to the same stressors that cause pyriform heads and are often seen in association with pyriforms. They may interfere with fertilization or cause reduced embryo viability. Reevaluation at 1-2 month intervals is recommended.
**Knobbed Acrosomes**

Although not clearly distinguishable with a light microscope, the acrosome is a sac-like structure positioned on the top of the sperm cell head. It contains enzymes that assist the sperm in attaching to and penetrating the egg. The defect appears as a flattened or cup-like indentation on the apex of the sperm cell. Presence of this defect indicates a disturbance in sperm cell development as a result of stresses such as abnormal testicle heat regulation, illness, nutritional deficiencies, etc. and therefore will often be present with other defects caused by similar problems. It may also indicate an inherited component when present as the only defect in high numbers for prolonged periods of time. Again, a prognosis for improvement must take into account other defects present. If a predisposing cause can be corrected the prognosis is more favorable. When it occurs at a high percentage in otherwise good quality semen, a genetic basis is likely and the prognosis for improvement is poor.
**Coiled principal piece**

Appears as a tight coiling of the lower part of the tail and results in impaired motility. The cause is likely a result of abnormal tail formation during sperm development, again associated with some of the stresses that cause other defects. The defect appears more prevalent January through April (3). As with many of the other defects, if the inciting stressor is removed the prognosis for improvement is favorable.

**Dag defect**

Appears as a folding and coiling of the tail and with adequate magnification actual fracturing of certain elements of the tail can be seen. This defect will impair sperm motility and may have an inherited basis when observed in high numbers.
**Penile warts**

These are caused by the Bovine Papilloma virus. They vary in size and location, making them more or less difficult to remove. When large they will interfere with breeding due to discomfort. Often they will bleed which can cause infertility since blood is toxic to semen. Most can be removed with combinations of surgery, freezing with liquid nitrogen and electrocautery.

![Penile Wart Image](image)

**Persistent frenulum or tie**

This is a problem seen mainly in young bulls. It results from the failure of the prepuce to fully separate from the penis during development, with the result being a band of tissue that extends from the prepuce to the penis. This limits the ability of the bull to fully extend the penis during breeding. If it is thin enough many of these will break when a bull first attempts to breed. However, it often is a thick strong band that must be surgically cut. It is important that all bulls have the penis fully extended during semen collection to detect this and other potential problems.

![Persistent Frenulum Image](image)
**Frostbite**

Cold weather along with lack of wind protection and clean, dry bedding can lead to frostbite of the scrotum. In a recent study (3) the frequency of frostbite was found to increase with age. This may be a result of more pendulous scrotal conformation in older bulls predisposing to frostbite. Infertility may result from the chilling effect on the testicles and also from the abnormal heat production that follows as a result of inflammation. In severe situations, the supercooling of the testicles may result in testicular degeneration with more prolonged or permanent infertility. If frostbite is not severe bulls will generally recover in 4 - 8 weeks although the scab may persist for months.
References


