VAGINAL SURGERY IN THE COW

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Contents

Summary

Farmers and veterinarians usually fail to appreciate the medical and economic benefits of vaginal surgical techniques. Some of these techniques are sufficient by themselves to solve fertility problems. They also solve problems such as urovagina, pneumovagina, vaginal tears and other minor problems of the reproductive tract. They offer many advantages: they can be scheduled and they are simple, inexpensive and fast. Moreover, these procedures often significantly improve the likelihood of pregnancy after artificial insemination. In this way, these techniques offer several economic benefits: they reduce the number of days from calving to conception (days open), the number of inseminations per pregnancy and the cost of maintaining herd size (replacement cost), while also enhancing genetic improvement. Moreover, these methods do not require any

pre- or postoperative antibiotic treatment, and no milk must be discharged. This chapter will describe the different vaginal pathologies and surgical techniques to resolve them.

1. Introduction

At present bovine surgery is not a fashionable issue. Buiatric practice seems to focus on herd health, mastitis control, reproduction, indexes, computers, time, and money. Scientific articles and conferences deal mainly with herds rather than individuals. It is as if large farms were not formed by cows, but were a unit unto themselves--"no ants, only the mound." The reality is quite different. Although very large cow farms do exist, the average farm is quite small with 30 cows per farm in the U.S. and even fewer in Spain. On all these farms, effective, fast and inexpensive surgical techniques are always very profitable for both the farmer and the veterinarian.

However, bovine surgery is not given much importance either in the world of animal surgery or in the curricula of veterinary schools. Most discussion is related with small animals' surgery, and large animal surgery is almost limited to equine procedures. This is not realistic, since bovine practitioners are routinely called upon to perform bovine surgery, and these cases cannot be submitted to specialized clinics as can be done with other species.

The most common surgeries in cattle are Cesarean section (C-section) in beef cows, and abomasum displacement in dairy cows. Other common surgeries are related to problems of the rumen, cecum, teats, feet, eyes or abdominal hernias. C-section is the most common bovine surgery for treating reproductive tract problems. Additionally, uterine and vaginal prolapse are urgent problems that require fast and effective surgical treatment, and thus such methods have also received attention.

Moreover, vaginal surgical techniques can be used to resolve fertility problems, but since these problems are not regarded as medical emergencies, farmers and veterinarians alike are usually unaware of their economic benefits. By resolving urovagina, pneumovagina, vaginal tears and other minor problems of the reproductive tract, these surgical procedures dramatically increase the probability of pregnancy after artificial insemination.

2. Anatomy Fundamentals

The anatomy of the reproductive tract is one of the best-studied of all the organ systems in the cow. Indeed, the cow was the pioneer species in reproductive studies, and the first model for developing assisted-reproduction techniques such as artificial insemination and embryo transfer. Studies of the cow reproductive tract have been facilitated by the fact that it is easy to explore by direct methods (inspection and palpation), and the fact that large numbers of animals are available on farms and in slaughterhouses.

Nevertheless, certain anatomical characteristics, primarily pelvic conformation and body condition scores, have been described as predisposing factors of reproductive pathologies in the mare, and in a lesser extent in the cow.

This chapter will first provide an overview of the external reproductive anatomy of the cow, and then discuss the main anatomical features of reproductive pathologies.

2.1. Anatomy of Cow External Genitalia

Knowledge of cow genital topography is necessary for some exploration methods, such as transrectal examination and ultrasonography, as well as for diagnosing pregnancy and identifying reproductive pathologies and their prognosis (Betteridge, 1970). The entire reproductive tract, except for the vulva, is located within the cow body, in the pelvic abdominal region. Its topography, which changes over the various stages of pregnancy, comprises the following structures.

2.1.1. Vulva

The vulva is the external part of the reproductive tract and it is located ventrally to the anus. It is usually in a vertical position, with 20% located on the caudal edge of the pelvic floor and 80% below it (Grunert and Berchtold, 1988). It consists of two vulvar labia, the dorsal and ventral commissures, and the clitoris.

- The vulvar labia are covered externally by skin and internally by a stratified epithelium. They contain a circularly arranged muscle layer (vestibular constrictor muscle), which continues dorsally to the external sphincter of the anus. The main function of this muscle is to occlude the labia, thereby helping to isolate the cranial part of the genitals from the outside.
- The dorsal and ventral commissures are formed by the joining of the lips dorsally and ventrally, respectively.
- The clitoris is the homologue of the penis. It is 5-10 cm long and is located in a cranio-ventral position, usually covered by the lower third of the labia. Irrigation is supplied by urogenital and internal and external pudendal arteries. The innervation is the same as in the vagina. However, the vulva contains additional sensory fibers of pudendal and genital nerves (Sisson and Grossman, 1953).

2.1.2. Vagina

The vagina is located in the pelvic cavity and it limits cranially to the cervix, caudally to the vulva, dorsally to the rectum and anus, and ventrally to the bladder, urethra and pelvic floor. It is the site of semen deposition during natural service. The vagina also serves as passage for the calf during calving. Another important function is to act as a line of defense, in which secretion of fluids by vaginal epithelium inhibits the growth of undesirable bacteria. Irrigation and innervation are provided by urogenital artery branches and the internal pudendal and pelvic autonomic nerve plexus. The vagina consists of the following three parts, in order from cranial to caudal: the vaginal fundus, the body of the vagina and the vaginal vestibule (Sloss and Dufty, 1980).

- The vaginal fundus is the most cranial part of the vagina, continuing with the cervix, which usually makes a short protrusion into the lumen at this portion. The vaginal fundus is broad and deep dorsally, but shallow and smooth ventrally.

- The body of the vagina is the longest portion of the vagina, extending for 25-30 cm. The line of demarcation between the body of the vagina and the vestibule is not obvious, except in the ventral part. Ventrally, a transverse fold, called the hymenal ring closure, covers the external opening of the urethra (Sloss and Dufty, 1980). This ring is formed by the medial part of the levator ani muscle, which runs along the pelvic diaphragm, and the bulbocavernosus muscle, also known as the vestibular constrictor muscle. The bulbocavernosus muscle originates on both sides of the ventral surface of the tendinous levator ani muscle, and it is reinforced by fibers of the levator ani muscle, giving rise to a thumb-sized muscle with spiral morphology. The union of these muscles constitutes the hymenal ring. These muscles run laterally, above the vestibular glands, and insert into the raphe on the ventral floor of the vagina at the suburethral diverticulum. In the young female, rudiments of the hymen usually remain as a ventral band. This structure is disrupted during natural service or artificial insemination, and less frequently during calving. However, the hymen can also remain throughout the life of the animal.

  The vaginal vestibule is approximately 10-12 cm long, limiting caudally with the vulva. This region contains the following structures:
  - Gartner ducts, which may end blind or open near the opening of the urethra;
  - Minor vestibular glands, located on the vestibular floor along its midline;
  - Greater vestibular glands or Bartholin's glands, which have a diameter of 1.5-3 cm and are located lateral to the glands above at the height of the urethra;
  - Suburethral diverticulum, which is 2.5-4 cm long and is located in a cranio-ventral position.

2.1.3. Cervix

The cervix lies between the vagina and uterus. It is a powerful muscular tubular sphincter consisting of 3-5 musculo-fibrous bands with almost cartilaginous consistency, and it is designed to restrict access to the uterus. Although it is usually located in the pelvic cavity, it is frequently found on the cranial border of the pelvis or even in the abdominal cavity (Miller, 1989). The cervix wall is harder, thicker and stiffer than the uterine or vaginal wall, especially in multiparous animals, and although the entrance of the cervix does not project into the vagina, it may appear to do so in multiparous cows with prolapsed rings (Sloss and Dufty, 1980). The length of the cervix varies between 5 and 10 cm, and its diameter between 1.5 and 7 cm, and cervical size increases with age and parity. Within the cervix, three or four rings, called annular folds, can be distinguished. Although the cervix of the cow is difficult if not impossible to dilate manually, it expands naturally during estrus and delivery. Irrigation is provided by branches of the uterine artery and vaginal artery, while innervation comes from fibers of the pelvic autonomic nerve plexus (Arthur et al., 1991).

2.2. Closures or Seals of the Cow Genital Tract

One of the main functions of the external genital tract is to keep the uterus isolated from the environment. This is accomplished through three well-defined seals that prevent the entry of environmental agents into the uterine lumen. These seals are the following, in order from caudal to cranial:

- First seal: the vulva (vulvar constrictor muscle). This is the first external seal that isolates the vestibule from the environment.
- Second seal: this is located between the vaginal vestibule and the vaginal body, and it comprises the vaginal levator muscle and the hymenal constriction. In addition to isolating the uterus from the outside, this structure prevents the reflux of urine into the cranial part of the vaginal body.
- Third seal: the cervix. It separates the vagina and the uterus (Sloss and Dufty, 1980).

2.3. Relationships between External Genitalia and Other Anatomical Structures in the Cow

Some anatomical characteristics related to vulvar conformation, pelvic bone conformation and body condition score (BCS) may predispose the animal to reproductive pathologies, and thus to a reduction in fertility. These relationships have been studied primarily in mares, where a proper vulvar seal is considered very important to prevent pneumovagina and achieve maximum reproductive efficiency. Pascoe (1979) developed a formula to predict a mare's predisposition to reproductive difficulties on the basis of conformation. He correlated vulvar length and angle of inclination of the vulva, deriving the "Caslick index," which is obtained by multiplying the angle of inclination of the vulva and the distance from the ischium to the dorsal commissure. This index can be used to classify mares into three types, allowing the prediction of reproductive problems. Mares with a Caslick index > 150 were found to experience more numerous and severe reproductive problems, principally pneumovagina and urovagina. Pascoe (1979) concluded that mares with a Caslick index > 100 should be treated surgically to avoid future complications.

This work in mares identified two key aspects of vulvar conformation: the angle between the vulva and the horizontal line and the length of the vulvar commissure. These anatomical relationships are poorly studied in the cow. Ayala et al. (2001) showed that, in the cow, the percentage of the vulvar commissure that is above the caudal edge of the pelvic floor is more important than its total length. A defective vulvar conformation favors the appearance of faults in the first and second vaginal seals, allowing the entrance of fecal material, air and other external agents. This increases the risk of pathologies such as urovagina, pneumovagina and metritis, causing reproductive problems and reducing fertility (St Jean et al., 1988; Gilbert et al., 1989; Celly, 1990).

In the cow, the physiological position of the vulva is vertical, 90° to the horizontal, with 80% of the vulvar commissure below the caudal edge of the pelvic floor (Grunert and Berchtold, 1988). A defective vulvar angle (>90º) has two main causes: an elevated percentage of the vulvar commissure located above the caudal edge of the pelvic floor, and poor body condition. Regarding the first cause, the vulvar angle depends directly on the percentage of the vulvar commissure located above the caudal edge of the pelvic floor. The higher the percentage of the vulvar commissure located above the caudal edge of the pelvic floor, the less likely it is to be dragged cranially. Ayala et al. (2001) observed a greater incidence of urovagina and pneumovagina in cows in which the vulvar commissure was located more dorsally, on the floor of the pelvis. Regarding the second cause, a lower BCS means fewer fatty deposits in the perivaginal area, which allows the upper third of the vulva to shift to a cranio-ventral position. The BCS is

particularly important in cows with a vulva positioned dorsally, since a loss of only 2 BCS points (on a scale of 1 to 5) is sufficient to increase the vulvar angle. This problem can also occur in animals that have the optimal vulvar conformation but that suffer from cachexia. Indeed, low BCS is considered a cause of urovagina and neumovagina (Celly et al., 1990).

Another structural aspect of the cow reproductive tract that can affect fertility is pelvic conformation. The most important issue is the hip angle, which is the angle formed between the ischia and coxal tuberosity. This relationship directly affects reproductive indices, facilitating or preventing proper drainage of the reproductive tract (Watson, 1984). The hip angle also significantly affects vulvar conformation. It has been shown that the caudal reproductive tract (vulva and vagina) occupies a more cranio-ventral position in animals with ischial tuberosities at the same level as, or above, the coxal tuberosity (Figure 1), which is known as splacnoptosis vulvar (Figure 2). In addition, animals that have a sloped hip angle tend to have a smaller percentage of vulvar commissure below the pelvis edge. Variation in the vulvar angle is less frequent in cows with a desirable hip angle; in these animals, the vulvar commissure is normally found in a physiological position (Ayala et al., 2001).

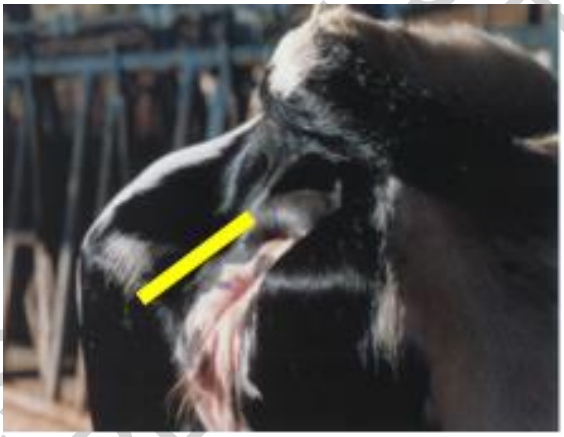

Figure 1. Sloped hip angle

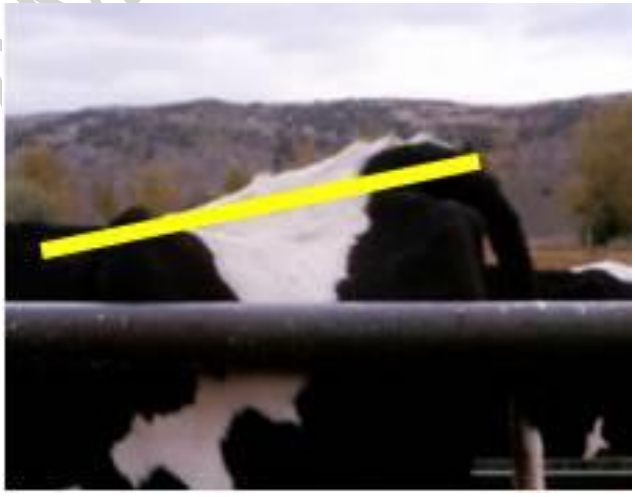

Figure 2. Vulvar splacnoptosis

3. Genital Tract Exploration

3.1. External Exploration

External examination can be performed by inspection and palpation, and no special containment methods are required. It can be performed during routine reproduction visits. First, the anatomical integrity of the entire area should be checked, paying attention to the presence of second- and third-degree perineal injuries. Second-degree lacerations affect the vulva and perineum; third-degree lacerations affect the vulva, perineum and rectum. If injuries are present, the stage of healing should be determined in order to identify the best treatment method and timing.

The position and anatomical relationships of the various organs, especially the vulva and the pelvis, as well as the BCS and the degree of depletion of the ischiorectal fat should also be evaluated.

Finally, the efficiency of the vulvar and hymenal constriction closure should be checked, which can be done by opening the labia with two fingers and observing whether air enters the vagina when the diaphragm creates negative pressure during expiration. It should be noted that mild vaginal closure failure is observed only during estrus due to the relaxing effect of estrogens on connective tissue.

3.1.1. Rectal Palpation

Rectal palpation is the standard examination method at reproduction visits. It normally involves locating the cervix, usually at the midline anterior border of the pelvic floor, followed by exploring the uterus and ovaries.

The vagina is usually unnoticed, except when pneumovagina is present. Rectal palpation can also allow the diagnosis of perivaginal masses as being, for example, fatty nodules or abscesses. A complete reproductive diagnosis is always necessary before vaginal surgery can be undertaken, since it is contraindicated when injuries incompatible with pregnancy are present, such as adhesions.

3.1.2. Vaginal Examination

This exam is not routinely performed. It requires more extensive animal containment measures than are normally necessary, as well as previous cleaning and disinfection. It is not essential for diagnosing the most important vaginal diseases, but it is necessary when exploring the vestibule and when identifying cases of urovagina involving small amounts of urine. In addition, inflammation of the vagina (vaginitis) or uterine wall (metritis) can be diagnosed only by ultrasonography or vaginal examination, either manually or with a speculum.

4. General Presurgical Considerations

4.1. Immobilization and Anesthesia

4.1.1. Immobilization

Vaginal surgery is always performed with the animal standing up, except for cervix fixation to the prepubial tendon. Therefore, the animal should be immobilized through a halter that is tied as short as possible to a fixed location. The tail should be tied with a rope to one anterior extremity and then tightened to expose as large a field as possible (Figure 3).

If the animal's head is properly immobilized and the animal is adequately anesthetized, the surgery can usually be carried out with two assistants, one on each side of the animal.

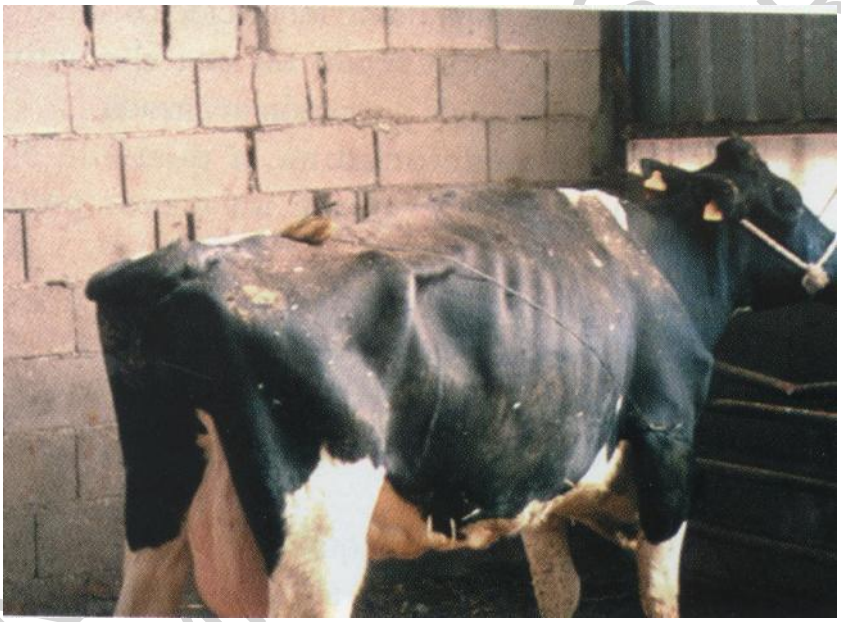

Figure 3. Proper immobilization of a Holstein cow

4.1.2. Anesthesia

Most examinations and surgeries of the vaginal area can be performed only with restraint and regional anesthesia. However, sedation or tranquilization is indicated when adequate facilities are unavailable or if the animal is excessively nervous. In fact, tranquilization can be helpful even when surgeries are performed under optimal conditions, since it will leave us less anxious and better able to focus on the surgery. However, as surgeries are performed with the cow standing up, overdosing should be avoided in order to prevent the animal from lying down.

Most tranquilizers used in cattle are α-2-agonists. The most common cow tranquilizer has traditionally been xylazine (Caron and Leblanc, 1989), and several drugs used in horses have recently been extended to cows, such as detomidine, medetomidine and

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