Teat and Udder Anatomy

The term “udder” refers to the sac containing the mammary glands and ducts. Cattle have 1 udder that is divided into 4 quarters, and each quarter is attached to 1 teat. Each quarter is separate from one another. Supernumerary (extra) teats are possible and are usually associated with separate glandular tissue. Supernumerary teats that grow at the base of a teat is termed conjoined teat or web teat. Species differences exist among ruminants. Sheep and goats have an udder that is divided into 2 equal parts and alpacas have an udder similar to cattle with 4 quarters.

The medial and lateral suspensory ligaments provides support for the udder. Blood supply to the udder is predominantly provided by the paired external pudendal arteries and veins. This vasculature courses though the inguinal rings of the body wall. The perineal artery and vein also provides blood to the udder and runs along the caudal aspect of the udder in the perineal region. Paired subcutaneous abdominal (caudal superficial epigastric) veins are referred to as the “milk veins” and run cranially from the udder.

Glandular tissue drains into a network of ducts, which coalesces into a large central cavity known as the “gland cistern”. During a process known as “milk letdown,” milk secreted by the mammary gland is squeezed though these ducts and collects in the gland cistern. The gland cistern is continuous with the teat cistern, which is a cavity in the center of the teat. There is an annular (vascular) ring which encircles the junction of the gland cistern and teat cistern. Blood vessels that supply the teat originate in this area and course distally through the wall of the teat. The rosette of Furstenberg is an area at the distal end of the teat cistern that encompasses a muscular ring called the teat sphincter. The channel through the distal portion of the teat from the teat cistern is termed the streak canal. The streak canal is lined by stratified squamous epithelium and is covered by keratin. Maintenance of streak canal integrity is important in the prevention of mastitis. The teat orifice is the hole on the bottom of the teat and represents the opening of the distal end of the streak canal.

The wall of the teat is made up of 5 histologic layers. From superficial to deep these layers are:

1. Skin (stratified squamous epithelium)
2. Muscular layer (both circular and longitudinal muscles represented)
3. Highly vascular connective tissue layer
4. Submucosa
5. Mucosa.

From a clinical standpoint, these are simplified into 3 layers (the skin, submucosal layer, and the mucosa). These are the 3 layers that we close when closing a thelotomy (teat incision). The mucosal layer provides a seal for milk, the submucosa is regarded as the primary holding layer, and the skin provides protection against environmental contamination.
Examination

Examination of the teats and udder should be part of a routine physical examination on any lactating dairy cow. The udder and teats should be checked for abnormal size. Enlarged teats or udder may indicate that the udder is not being drained adequately or that mastitis is present. The teats should point straight down to the ground. Changes in confirmation where the teats point outward may be indicative of a suspensory ligament rupture. Increased number of teats is indicative of supernumerary teats.

The udder and teats should be palpated. Enlarged udders that are firmer than normal and are warmer than normal likely are affected with mastitis. Udder edema is common in first calf heifers but also may be a sign that inflammation is present. Even cows that have recently been milked should have a small amount of residual milk in the teats. The teat cistern should feel uniform and milk filled. Any fibrotic masses or hard nodules are an abnormal finding. Ultrasonography can be a useful adjunct to the physical examination when looking for specific udder or teat lesions.

A few squirts of milk should be expressed from each of the teats. This process is called stripping. Check for ease of milking. The milk should not flow spontaneously from the teat (although is common if the cow has not been milked for a long time), but should be expressed with relatively little difficulty. The milk should be tested for mastitis using a black plate test and a California mastitis test (CMT). The black plate tests for clinical mastitis (chunks, clots, and flakes) and a CMT tests for subclinical mastitis (increased number of white blood cells within the milk). Milk from every quarter should be evaluated individually because of the separate nature of the glands.

Supernumerary teats

Supernumerary teats are extra teats found on the udder. The glandular tissue associated with these teats are separate from the primary teats and the supernumerary teats are usually smaller than the primary teats. Supernumerary teats are the most common congenital anomaly of the teats and udder. This is mostly a cosmetic blemish in dairy cattle. In beef cattle, they do not pose a clinical problem. Bovine milking machines are designed to milk four teats; therefore, supernumerary teats can pose a problem for proper milk-out. The associated glandular tissue is also susceptible to mastitis.

Supernumerary teats are most easily dealt with in young heifers. Teats in heifers from 4-6 months old can be removed with scissors and left to heal by second intention. Teats of older heifers should be surgically removed and sutured primarily. However, in very young calves, discerning the supernumerary teats from the primary teats can be more challenging.

Conjoined teats, commonly called “web teats” are supernumerary teats that are located on or at the base of a primary teat. It may or may not have a teat orifice and or glandular tissue. Removal of the
conjoined teat involves excision of the entire conjoined teat down to the primary teat cistern. Routine, 3-layer closure of the incision follows.

Teat Fistulas

A teat fistula is a hole on the surface of the teat that has a communication to the primary teat cistern. There is no glandular tissue associated with teat fistulas. Milk may spontaneously leak from the fistula or it may only be evident when the teat is milked. Since teat fistulas represent a communication directly into the primary teat, the chance of mastitis increases. Similar to removal of conjoined teats, an elliptical or fusiform incision is made around the fistula down to the primary teat cistern. A 3-layer closure (mucosa, submucosa, and skin) follows. Make certain that the long axis of the ellipse is oriented with the long axis of the teat to avoid compromising blood flow.

Teat Trauma

Teat trauma may result from teats being stepped on or frostbite. Milking equipment that is malfunctioning or milking errors can also lead to teat trauma. The most common traumatic injury to present to a veterinarian is lacerated teats. Teat lacerations can lead to teat fistulas as they heal. If the lacerated teat is presented within the acute stages (<6-12 hours) the teat may be cleaned, debrided of severely damaged tissue and sutured primarily with good results. After this “golden period” the inflammation that accompanies teat injuries usually prevents proper teat wound healing. Older wounds are best addressed with delayed primary closure. The wound is managed conservatively for several days with antibiotics, anti-inflammatories, pain control, and other wound management techniques (hydrotherapy recommended) in attempt to allow inflammation to decrease. The wounds are then debrided and surgically closed. Full thickness lacerations are closed in three layers (see General principles of teat surgery). Lacerations should be debrided back to fresh, bleeding tissue before closure.

Lacerations near the base of the teat have a more favorable outcome than distal lacerations because the blood supply is better near the teat base. Lacerations oriented vertically generally have a more successful outcome than circumferential lacerations because circumferential lacerations disrupt the neurovascular supply to the distal teat.

Hard Milker

A “hard milker” is a term used to describe a teat that has increased resistance to milk flow. The owner notices that it takes longer to milk the affected quarter than the other quarters. Upon evaluation, the gland and teat cisterns appear full. Causes included skin or an imperforate membrane at the distal teat end, fibrosis within the teat itself (teat spider), or a stenotic streak canal/teat sphincter.
Imperforate membranes at the distal teat end can be simply opened up with a scalpel or a 14-gauge needle. The milker is instructed to roll the teat end in their fingers and strip the teat for a few days at milking time to keep this area patent.

Tight streak canals can be a congenital problem noticed when the cow has her 1st lactation. It can also be caused by teat trauma, usually due to chronic trauma from poor milking machine function. Swelling and fibrosis of the distal teat cistern and contracture of the teat sphincter follows. Correction involves cutting the teat sphincter with a teat knife until the resistance to milk flow is decreased. Typically, cuts are made until milk flows spontaneously from the teat. Care should be taken to not disrupt the keratin lining of the streak canal or mastitis is likely. The milker is instructed to roll the teat end in their fingers and strip the teat for a few days at milking time to keep this area patent and prevent the cuts from structuring. Teat dilators can also be used to stretch the teat sphincter and the streak canal. Mastitis is a potential complication of frequent insertion of teat dilators.

A “teat spider” is a term given to fibrosis (scar tissue) within the teat cistern. They can present as mural plaques that protrude into the teat cistern, pedunculated masses that projects into the teat, or they can be free-floating balls of scar tissue, which can lodge against the distal teat opening obstructing milk flow. Small pedunculated masses or free-floating balls may be grasped with small alligator forceps and removed through the distal teat orifice. Although larger lesions or intramural lesions can be removed via an approach through the distal teat orifice, they are best removed with a thelotomy (teat incision). The thelotomy incision is made on the teat side opposite the lesion. The lesions are gently dissected out of the wall and the mucosa is closed with fine absorbable suture. The thelotomy is closed in a routine, 3-layer closure. Theloscopy (teat scoping) is another method of dealing with lesions within the teat cistern.

More generalized fibrosis of the teat cistern is also possible. The extent of the fibrosis should be evaluated by palpation and ultrasound. Severely fibrotic teats have a poor prognosis for reestablishment of patency. Obstructions can also occur in the area of the annular ring. Thin membranes or thicker fibrosis can inhibit the flow of milk from the gland cistern to the teat cistern. Teat implants may be successful at establishing patency in these cases. Occasionally the vessels that are present at the annular ring dilate and physically impinge on the teat cistern. In these cases, we have had success in external ligation of vessels in this area without implants.

Teat and udder amputation

Regarded as a “last resort,” the indication for teat amputation includes non-reparable teat damage and toxic mastitis. In cases of toxic mastitis, toxins produced by gram-negative organisms accumulate within the milk. Reabsorption of these toxins can cause endotoxemia. Teat amputation is a method to provide continuous drainage of the quarter so that these toxins do not accumulate within the
gland. Indications for udder amputation include gangrenous mastitis or severe toxic mastitis involving several quarters. Precocious udder or aberrant lactation syndrome in goats is best treated with a radical mastectomy.

Teat amputation is performed by clamping across the proximal teat base near the vascular ring with a Burdizzo emasculatome to crush the teat and provide hemostasis. The emasculatome is left in place for at least 2 minutes. The teat tissue distal to the emasculatome is transected. After removal of the emasculatome, multiple horizontal mattress sutures are placed around the circumference of the teat to ligate the vessels of the teat wall. The mattress sutures should encompass full thickness teat wall.

Udder amputation of a cow is a major endeavor with a relative high risk of shock and death. Clients are warned accordingly. The principles of surgery are simple and involve an elliptical incision around the udder, blunt dissection to break down fascial tissue attaching the udder to the body, cutting of the lateral and medial suspensory ligaments, and **GOOD LIGATIONS**. The external pudendal arteries should be located early in the procedure so that they are not inadvertently transected without ligation. If this happens, profuse bleeding will result! The author typically will triple ligate the pudendal vessels with #2 - #3 chromic gut suture. This surgery creates a lot of dead space so Penrose drains are placed to avoid seroma formation. Because a lot of tissue is removed, there is substantial tension on the skin closure, which can be reduced by holding the legs together. Hobbles placed post operatively helps to minimize tension on the incision. An alternative approach to the skin incision involves the creation of pedicle flaps (cloverleaf pattern) and reduces the amount of tension on the final skin closure, but possesses a higher risk of inadvertently cutting into the glandular tissue.

**General principles of teat and udder surgery**

Most teat surgery is performed with the cow awake. Heavy sedation may be helpful if the animal is resistant. The animal is usually restrained in lateral recumbency on a tilt table or casted with ropes to expose the teat and udders. If possible, the up leg is abducted and tied out of the way. Local anesthesia of the teat is adequate to anesthetize the teat for minor surgical procedures. To perform a ring block, local anesthetic is injected proximal to the intended surgery site circumferentially around the teat, intercepting nerves that run longitudinally down the teat. General anesthesia may be useful for long procedures such as mastectomy.

Incisions within the teat should be oriented vertically (with the long axis of the teat). Because the neurovascular structures run longitudinally in the teat, vertical (longitudinal) incisions tend to disrupt these neurovascular structures less and increases prognosis and recovery time. Circumferential incisions and lacerations tend to cause avascularity and denervation to the teat distal to the incision. Thelotomy incisions to approach lesions within the teat cistern should be made on the teat side opposite of the lesion. This allows for better visualization of the lesion.
When suturing full thickness teat defects, a 3-layer closure should be employed. The mucosa should be sutured as the first layer. This creates a seal and does not allow milk to escape through the other layers of the teat. Very fine (4-0) monofilament, absorbable, suture is recommended. The submucosa is the holding layer and special care should be taken to grab substantial bites of submucosa. Fine absorbable suture is also used for the submucosa layer. The skin is sutured with non-absorbable or absorbable suture.

If closing teat defects with a lot of tension, tension-relieving sutures may be used in the skin. Vertical mattress sutures can help to reduce the likelihood that sutures will pull through the skin. Feeding sutures though stents can also help to distribute tension and reduce the likelihood of sutures pulling through the skin.

Always remember that the teats are a delicate structure and gentle manipulation is important (“Do no harm”). Rough handling of the teat in surgery can cause excessive trauma, inflammation, and fibrosis. Excessive scar tissue in this location can create a “hard milker.”

Aftercare is an important part of teat surgery. Following teat surgery, we would like to allow the teat to heal in an atraumatic environment. Hand milking is very disruptive to the teat. Machine milking is less disruptive than hand milking and is recommended following teat surgery. The quarter can also be drained passively by inserting a teat cannula into the teat. Sterile technique should be followed when inserting teat cannulas. Frequent cannulation of a teat increases the likelihood of developing mastitis. It has been shown that cattle can be left without milking for up to 5 days without a decrease in milk production.