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Lactation and Udder Diseases (11 Dec 2000)

A. Tibary and A. Anouassi

Department of Veterinary Clinical Sciences, College of Veterinary Medicine, Washington State University, Pullman, Washington, USA.
Veterinary Research Center, Abu Dhabi, United Arab Emirates.

Physiology and diseases of the udder are an important facet of reproduction and production of *Camelidae*. Camel milk has been a source of nutrients for millions of people in African, Middle-eastern and Asian countries. Several types of camels have been identified as potential "dairy" breeds and could be used as a source of protein for these populations in drought stricken areas. Mammary gland function is also very important for the health and growth of newborns since udder diseases are known to have a negative effect on both of these factors and can pose public health hazards for populations consuming camel milk [1,2]. Llamas are also kept for milking in some parts of South America [3].

Anatomy of the Mammary Gland in Camelids
In the prepuberal and nulliparous females, only the small teats are visible as the mammary tissue does not develop until the end of the first pregnancy. At the peak of lactation, the udder has increased in size and shows well-developed venous drainage. The udder of the camel consists of four glandular quarters, each with its own teat [4]. The left and right halves of the udder are separated from each other by fibroelastic tissue extending from the linea alba and prepubic tendon and a groove is generally visible between the left and right halves. The lateral aspect of the quarters is covered by tissue from the abdominal tunic and the caudal abdominal wall. The anterior and posterior quarters are independent but there is no visible separation between them [5] and the teats that are directed cranio-ventrally possess two openings. Conformation of the udder can change according to breed, age and stage of lactation (Fig. 1).

Figure 1. Conformation of the udder in camelids; top: alpaca near term, bottom: lactating dromedary, note the two streak canals per teat.

In South American *Camelidae*, contrast radiography has shown that each quarter is composed of two distinct glands each leading to a separate streak canal within the respective teat. The udder is therefore, composed of 8 separate glands [6].
Each mammary gland consists of parenchyma, connective stroma, ducts and alveolar systems. The gland is made of several individual lobules separated by septa of connective tissue (interlobular connective tissue). The glandular units of the lobule, the alveoli or acini, are separated from each other by the intralobular connective tissue which projects from the interlobular connective tissue [4] but there are no anastomoses between glands [6]. The duct system begins with small intralobular ducts that enlarge progressively and each duct is lined by an epithelium resting on a distinct basement membrane. The duct epithelium is low, simple and secretory in the smallest intralobular duct but becomes columnar in the larger ducts [4].
The secretory units, acini or alveoli, are small vesicles of unequal sizes that form the lobule-alveolar system. The epithelial lining of the alveoli (flattened to columnar epithelium) shows great variation

according to stage of lactation and secretory activity of the gland. In the non-lactating female, the number and size of alveoli per lobule decreases, the parenchymatous tissue regresses and the interalveolar space becomes filled with interstitial connective tissue [4].

Lactation and Milk Production

Milk Composition in Llamas and Camels

It is very important to know the composition of camelid milkto evaluate its nutritive value for humans, as well as for the formulation of milk replacers for orphans and cases of agalactia. Milk replacers are used in camel production to allow for earlier weaning to shorten the postpartum anestrus in dromedaries and Bactrian camels [7].

A detailed study in the United States of America showed that llama milk has a higher sugar content (6.5%) and lower fat content (2.7%) than milk from other domestic ruminants [8]. Llama milk contains more calcium and less sodium, potassium and chloride but the concentration of trace minerals is similar to that found in bovine milk. Milk composition can vary between different geographical locations and is probably due to differences in diet and management [8]. However, the composition of milk is not affected by stage of lactation, lactation number or body condition score.

In camels, variations in milk fat and protein have been attributed to breed, nutritional management, stage of lactation and milk sampling techniques [9]. Information on milk production in camels has been collected during several field observations but to date there is no controlled study. All observations made in the field point out two important facts: the camel has a high potential for milk production (at least some breeds) and in the desert environment, camels outperform any other species for milk production. Lactation length varies from one region to another (from 8 to 24 months) and milk production varies from 1500 to 12,775 kg. Milk production adjusted for a 305 day lactation ranges from 1000 to 10,600 kg. with the average daily milk yield for camels ranging from 1.5 to 8 kg [2,10-13]. In one study, camels in late lactation produced an average of 10.23 kg per day with some individual females producing up to 18 kg per day [9]. These authors showed that increasing the milking frequency improves milk yield.

It is important to note that milk production in camels is not affected by water restriction. In a study by Yagil [11,12] no effect was observed on lactation when water intake was restricted to once per hour, given *ad libitum* or once every 10 days. This illustrates how well adapted camels are to milk production in desert conditions. Generally camel milk compares very closely to that of cattle with the exception that it is high in vitamin C and low in fat. Dehydrated camels secrete milk that is even lower in fat (1%).

Udder Diseases in Camelids

Conformation Problems

Several udder conformation problems have been described in South American Camelids [6] and in the dromedary [14] but supernumerary teats seem to be more prevalent in llamas and alpacas. The embryological origin of this conformation problem has been discussed in detail by Fowler [6], and in the USA, presence of supernumerary teats disqualifies an animal from being registered in the alpaca or llama registry. Other conformation problems include: small nipples (Fig. 2) or large bulbous nipples (Fig. 3a,Fig. 3b and Fig. 3c) making nursing difficult, and divergence from the vertical axis [6,14].

Figure 2. Udder conformation problems: Small front teats that may be hard to milk.

Figure 3a.

Figure 3b.

Figure 3c.

Figure 3a-c. Conformation problems: Large bulbous nipples, due to enlarged teat canal or cistern. These abnormal conformations may be the results of chronic mastitis or of blocked teat canals.

Agalactia or Hypogalactia

Agalactia and hypogalactia are relatively frequent in camelids particularly after the first pregnancy. In many instances, milk production is very limited during the first few days following parturition. The etiology of agalactia is unclear in camelids but it could be due to severe edema, problems in milk let down,

hormonal imbalances, nutritional problems or mastitis. In recent years, veterinarians in the USA have been experimenting with the use of Domperidone supplement to increase lactation efficiency. Domperidone is a D2 dopamine receptor blocker that is used for the prevention of fescue toxicosis and agalactia in pregnant mares.

Mastitis

Mastitis is a relatively infrequent disease in *Camelidae* compared with cattle, but the incidence of mastitis may increase in dairy camels due to hand milking and teat malformation [15]. Acute mastitis has been reported to occur during the first few days following parturition, dystocia or cesarean section in the dromedary [16,17]. Mastitis is characterized by alarming signs including anorexia, fever, general depression, swelling, severe inflammation and pain of the udder (Fig. 4) which can cause rejection of the newborn by the female.

Figure 4. Udder edema is very common in young primiparous females but can also be a sign of acute mastitis.

Mammary secretions in these cases are watery, yellowish or blood-tinged and the bacteria isolated include *Klebsiella pneumoniae* and *E. coli* [16]. Although some authors have suggested daily intramammary infusion with an antibiotic preparation as used in cattle, we are opposed to this practice because of the particular anatomy of the *Camelidae* udder and because of the difficulty in administering such treatments. Our therapeutic approach in treating acute mastitis is via systemic antibiotics (e.g., trimethoprim-sulfametoxazole or penicllin/aminoglycoside) and anti-inflammatory drugs (flunixin meglumine) with regular stripping of the mammary glands. Hydrotherapy is beneficial in reducing local edema.

Subclinical or chronic mastitis is suspected when the young fail to grow normally or when an anomaly of conformation of the udder is observed such as atrophy of one or more quarters, asymmetry or presence of pustules on the surface. The presence of pus or high cell counts (CMT) can be observed in milk [18,19]. Bacteriological analysis shows that bacteria such as *Streptococcus agalactiae*, *Streptococcus uberis*, *Streptococcus dysgalactiae*, Streptococcus pyogenes, *Diplococcus pneumoniae*, *Staphylococcus aureus*, *E. coli*, *Bacillus cereus*, *Corynebacterium bovis*, *Candida albicans* involved in cattle mastitis are also present in camelid mastitis [15,17,19,20]. The percentage of milk samples from CMT positive quarters yielding a positive bacteriological result can vary between 10 to 50% [15,21]. Treatment of chronic mastitis is very difficult and the condition often results in the loss of the affected quarter [19,20]. The correlation between udder infection and California Mastitis Test is debated.

In llamas, evidence of intramammary infection was found in 57% of the animals sampled in one study [22]. A variety of organisms have been isolated from llama milk samples that include several minor pathogens (*Staphyloccus* sp., *Micrococcus* sp and *Corynebacterium* sp) as well as major pathogens (*Streptococcus uberis*, *Streptococcus equinus* and *Enterococcus* sp.). However, clinical mastitis is rarely diagnosed in llamas and alpacas. *Streptococcus zooepidemicus* has been isolated in a case of mastitis in a llama with inappetence and fever 3 days after parturition. The llama was treated successfully with intramammary cephapirin and systemic antibiotics (ampicillin 11 mg/kg BW SC q 24 hours for 7 days) [23]. None of the common mastitis indicator tests used in cattle (somatic cell count, California mastitis test score, pH, N-acetyl-β-dglucosaminidae) proved to be useful in identifying sub-clinical infections [22].

Other Conditions of the Udder

Other conditions affecting the udder include traumatic lesions and lacerations (Fig. 5). In the dromedary, the udder skin can show typical lesions of camel pox and it is also the site of choice for tick infestation. In one study in Ethiopia, 72% of udders were infested by ticks. The incidence of mastitis was higher (30%) in heavily infested udders than in non-infested udders (9%) [15]. Teat canal blockage with dilatation of the gland is a commonly observed problem in dromedaries.

Figure 5. Udder lesions: a) blind quarter due to chronic mastitis; b) udder skin abscess, these lesions are usually due to severe infestation with ticks and fly larvae. c) Udder showing a severe dilation due to a blockage of the front left teat canal and a traumatic lesion of the right hind teat.

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