

Communication

[Comunicação]

Conventional and Doppler ultrasonography on a goat with gangrenous mastitis

[Ultrassonografia convencional e Doppler em cabra com mastite gangrenosa]

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Economic losses due to mastitis are high in small ruminants herds (Mota, 2008). The decrease in milk production, loss of product quality and sanitary aspects turning the final product unsuitable for consumption are important points related to this disease (Mota, 2008). Carlton and McGavin (1998) claimed that the most serious type of mastitis is the gangrenous type, usually occurring at calving season and affecting variable areas of the udder. It is a very aggressive form of the disease, with high morbidity and mortality (Abu-Samra *et al.*, 1988).

Imaging techniques like conventional and Doppler ultrasound have been used to study mammary tumors in dogs, allowing the characterization of malignant lesions in animals (Feliciano *et al.*, 2012; Souza *et al.*, 2013) and women, as well as to differentiate intraductal tumors and debris (Nastri *et al.*, 2011).

Studies on mammary gland ultrasonography in animals with mastitis were performed in other species such as cattle (Porcionato *et al.*, 2010) and buffalo (Rambabu *et al.*, 2009); however, ultrasonographic findings related to this disease in goats have not been described. Therefore, this study aimed to describe clinical and ultrasonographic findings on mammary lesions, not yet described in veterinary, of a dairy goat with gangrenous mastitis.

A two years old Saanen goat in its second lactation, fed with commercial balanced ration,

coast cross hay, mineral salt and water *ad libitum* was studied, dealing with experimental inoculation of *Staphylococcus aureus* in goats. This study was approved by the Ethics Committee at FCAV/UNESP under protocol number 011878/11. All animals had experimentally induced mastitis due to an intramammary inoculation of 1.6×10^{-3} colony forming units of *S. aureus*, but this goat was the only one that evolved to a gangrenous mastitis.

To diagnose the disease, the strip cup test and California Mastitis Test (CMT) were performed daily after inoculation. Mammary and physical clinical examinations as well as full blood counts were accomplished during six days after the experimental intramammary infection. The ultrasound evaluations were performed in a 48 hour interval basis, totaling three sonograms. They were obtained using the equipment Mylab VET30/ESAOTE microconvex multifrequency transducer (Genova, Ligúria, Italy) with a frequency of 5 to 7.5MHz.

The ultrasound images of the mammary gland were obtained at three different moments: a day before inoculation (M0), two days after inoculation (M1) and four days after inoculation (M2). Using the B-mode, echogenicity and echotexture of the breast parenchyma as well as milk echogenicity, diameter and area of the gland cistern, teat cistern diameter and surface regularity of the mammary structures were assessed. The evaluations were conducted on

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both mammary glands, with the left gland being the infected one and the right gland used as control.

Using colored Doppler, mammary artery was identified and evaluated. Subsequently, pulsed Doppler ultrasonography was used to determine the systolic peak velocity (SPV), end diastolic velocity (EDV), vascular resistance index ($RI = [SPV-EDV] / SPV$) and pulsatility index ($PI = [SPV-EDV]/\text{mean velocity}$) of the mammary artery. The caliper was then positioned in an area of the vessel to measure the spectral trace of the vascular flow, determining the indexes automatically (Feliciano *et al.*, 2012).

On the first day after inoculation, the strip cup test revealed the presence of small grumes in milk, while CMT reaction was classified as two crosses (++) in a scale from one cross (+) to three crosses (+++) of positive reaction.

Two days after inoculation, the animal presented local udder edema with clear positive Godet test, pain and increased local temperature. Milk was yellowish, watery and the strip cup test revealed various large grumes. CMT continued to be classified as two crosses positive.

On the third day following inoculation, the udder was observed to be cold, with no sensibility when manipulated and presenting hard nodules. Milk production was ceased and all that could be milked from the inoculated teat was a bloody discharge that no longer had characteristics of milk. As expected, CMT reaction was uncharacteristic (e.g. without gelatinization with strong color change). On the fourth day, mammary tissue was hard and dry.

The milk from the right (healthy) mammary gland, as the milk of healthy goats, presented none of the alterations associated with mastitis which were observed in the milk from the left mammary gland.

The animal showed a mild decrease in total leukon count from $15.7 \times 10^3/\mu\text{L}$ at M0 to $11.0 \times 10^3/\mu\text{L}$ at M1. At M2 (48 hours after inoculation), a marked leukopenia of $6.0 \times 10^3/\mu\text{L}$

was observed. On the following days, there was a gradual increase in these values. At ultrasonography, before inoculation, it was possible to clearly observe the alveoli in the mammary parenchyma, with good edge definitions and presence of anechoic content (milk), with little evidence of cellularity. The parenchyma echotexture was slightly coarse. The mammary cistern area was 5.17cm^2 and its diameter at the largest distance was 39.7mm. The diameter of the teat cistern in its farthest distance was 17.8cm. These values, obtained before inoculation, are similar to those found in healthy animals of the same research (i.e. mammary cistern area: 6.29cm^2 , mammary cistern diameter: 36.7mm and diameter of the teat cistern: 15.3cm) also, the echotexture was similar.

At M1 and M2, respectively, the difference between mammary cortex echotexture and milk within breast alveoli decreased, as well as the integrity of the alveoli edges, increasingly less defined. Furthermore, there were significant changes in the echogenicity of milk within the alveoli, resulting from increased cellularity (Figure 1).

At M1 and M2, the areas of the gland cistern were 1.90 and 1.62cm^2 , respectively. The diameter of the teat cistern in its farthest distance at those moments were 6.1 and 10.8mm, respectively, and the conformation of the cistern at M2, the moment of the greatest disease severity, appeared irregular.

At Doppler ultrasonography (Figure 2), SPV increased during disease progression, showing values of 15cm/s, 17cm/s and 29cm/s at M0, M1 and M2, respectively. The EDV assumed the following values at M0, M1 and M2 respectively: 26cm/s, 9cm/s and 16cm/s. It was also observed that the values of RI decreased with the progression of the disease, being 0.71, 0.61 and 0.43 at M0, M1 and M2, respectively. For the PI of the mammary artery, there was a reduction from M1 to M2, from 0.98 to 0.71. A healthy goat presented a SPV of 20cm/s, EDV of 29cm/s and RI of 0.45.

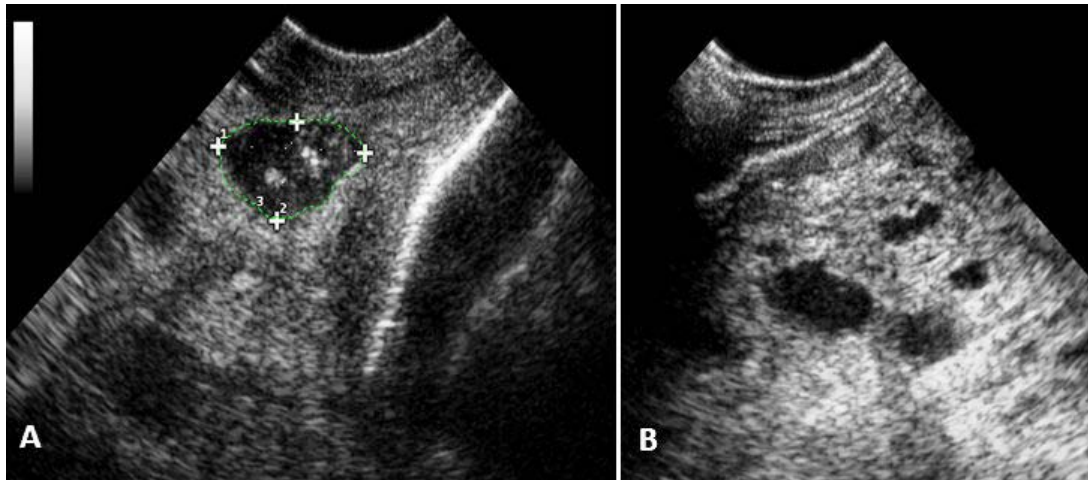


Figure 1. Ultrasound images of a mammary gland from a goat with gangrenous mastitis. Note in (A) the surrounded area showing heterogeneous echogenic content corresponding to the modified milk. In (B), note mixed echogenicity (hypoechoic and hyperechoic areas) of the breast parenchyma affected by mastitis.

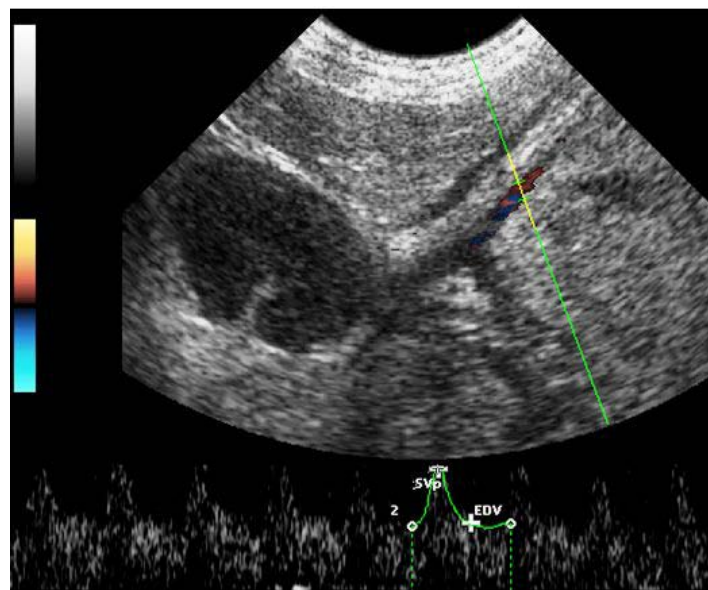


Figure 2. Doppler ultrasound image from the mammary gland of a goat with gangrenous mastitis, demonstrating the evaluation of vascular indexes.

The characteristics of the healthy mammary gland echogenicity were similar to those described in buffaloes (Rambabu *et al.*, 2009), mares (Gungor *et al.*, 2005) and cows (Ayadi *et al.*, 2003). With the onset of the disease in the mammary gland, there was an increase in parenchymal echogenicity. This result corroborates the findings of Rambabu *et al.* (2009) in buffaloes with mastitis who also observed increased echogenicity of this structure.

The worsening of symptoms coincided with increasing difficulty to delimit alveoli at ultrasound examination. Reduction of the gland cistern area according to the evolution of the disease may be explained by the thickening of the parenchyma.

In a study with bitches, there was a systolic peak velocity greater than 20 cm/s in tissue indicating malignancy (Feliciano *et al.*, 2012). This

increase in SPV is thought to be related to the moment of the greatest severity of illness and occurs due to an increased blood flow to the affected region, resulting from the inflammatory process.

The reduction of the RI values shows a decrease in vascular resistance, facilitating blood flow into the affected area. The features observed in SPV and RI in the present study corroborate findings from Miranda and Domingues (2010) reporting that these changes are part of an attempt by the body to increase blood flow in diseased organs.

There was a decrease of PI from M1 to M2, however, value found in the healthy animal was low in comparison with values cited by Feliciano et al. (2012), and it did not occur in the vessels studied in any of the researches cited in this short communication.

Alterations observed in the mammary parenchyma and milk at the three moments of ultrasound evaluations and the increase in SPV and RI values allow to establish a direct relationship between these variables and the severity of the disease. Further studies should be performed in order to attest the applicability of this technology for the diagnosis and prognosis of mastitis in goats.

It was possible to establish a direct relationship between ultrasonographic findings and disease severity. The conventional and Doppler ultrasonography can be used to study the hemodynamics of the goats mammary gland, favoring diagnosis and prognosis of alterations in this organ.

Keywords: goats, mastitis, ultrasonography, B mode, Doppler

RESUMO

Objetivou-se descrever os achados clínicos e ultrassonográficos de uma cabra leiteira apresentando mastite gangrenosa. Com a ultrassonografia convencional, observaram-se alterações consistentes com o avanço do quadro clínico, como alterações na ecogenicidade do leite e parênquima mamário. A ultrassonografia Doppler revelou aumento da velocidade de pico sistólico nos três momentos estudados, passando de 15 para 17 e 29cm/s. Houve redução, também, dos valores do índice de resistência, de 0,71 para 0,61 e 0,43. O índice de pulsatividade sofreu redução entre o segundo e o terceiro dia de observação, passando de 0,98 para 0,71. Foi possível estabelecer relação direta entre os achados ultrassonográficos e a gravidade da doença. A ultrassonografia convencional e Doppler podem ser utilizadas para o estudo hemodinâmico do úbere de cabras leiteiras, favorecendo diagnóstico e prognóstico de alterações nesse órgão.

Palavras-chave: cabra, mastite, ultrassonografia, modo-B, Doppler

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