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B-MODE ULTRASONOGRAPHY OF MAMMARY GLANDS IN GOATS DURING THE LACTATION PERIOD

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Summary

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The goal of the present study was to establish the ultrasonographic features of the mammary gland in goats during lactation. Twenty-four animals of a local breed within the first to fifth month of lactation, bred at the clinical facilities of the Faculty of Veterinary Medicine and private farms in the Yambol and Stara Zagora districts, were included in the study. During the B-mode ultrasonography of the different mammary structures, the 5 MHz ultrasound probe was placed in horizontal and vertical position related to the examined subject. Two methods of examination were used – direct (transcutaneous ultrasonography) and immersion of the examined organ in water ("water bath" method). The mammary papilla was best scanned in vertical position, whereas the mammary parenchyma – in horizontal probe position. The application of the "water bath" method was more effective when examining the mammary papilla, and the transcutaneous method – when examining the structures in the other areas of the mammary gland. There were differences in the visualizations of the separate structures of the udder, depending on the presence or not of the offspring. It is thus recommended to perform ultrasonography of lactating goat's mammary gland at least 2 hours after the last milking or separation of the offspring from goats.

Key words: goats, mammary gland, ultrasonography

INTRODUCTION

Mammary gland health is essential for goats' productivity (Smith & Roguinsky, 1977; Bergonier *et al.*, 2003; Contreras *et al.*, 2007). Production of high-quality milk and dairy products bears high social significance in Bulgaria and is closely related to the udder's condition (Zunev, 2003). Also, the preservation of the mammary gland's physiological function is an important premise for the breeding of healthy and vital offspring.

Ultrasonography is a non-invasive imaging technique, applied in the diagnostics of various physiological and pathological conditions of reproductive organs in animals (Carrière *et al.*, 2002; Dimitrov *et al.*, 2002; Georgiev *et al.*, 2003; Kähn, 2004; Yotov *et al.*, 2008).

B-mode, also known as real-time ultrasonography, is most widely used as the dynamics of the processes is shown in real time on the screen as a two-dimensional greyscale image (Dimitrov *et al.*, 2004; DesCôteaux *et al.*, 2010). The intensity of the reflected sound depends on the acoustic resistance (acoustic

impedance) between the closely located structures. The terms hyperechogenicity (high intensity), hypoechogenicity (low intensity) and anechogenicity (no reflection) are used for ultrasonographic depiction of these structures (Cartee *et al.*, 1986; DesCôteaux *et al.*, 2006).

A mammary gland examination was performed for the first time by Caruolo & Mochrie (1967) in cows using an A-mode ultrasonic device and 1 MHz transducer. Cartee *et al.* (1986) used B-mode ultrasonography via a 5 MHz linear probe and 5 and 10 MHz sector probes for diagnostic imaging of milk secretion disorders and structural changes of the mammary papilla in cows.

The potential of ultrasonography for examination of various physiological and pathological conditions of the mammary gland has been thoroughly studied for cows (Franz *et al.*, 2004; Klein *et al.*, 2005; Flöck & Winter, 2006; Franz *et al.*, 2009), buffaloes (Rambadu *et al.*, 2008), sheep (Ruberte *et al.*, 1994; Nudda *et al.*, 2000; Franz *et al.*, 2003; Hiepler, 2008; Rovai *et al.*, 2008), camels (Abshenas *et al.*, 2007), mares (Güngör *et al.*, 2005) and carnivores (Trasch *et al.*, 2007; Payan-Carreira & Martins-Bessa, 2008). There are few reports about such studies in goats.

The goal of this study was to establish the ultrasonographic features of goats' mammary glands during lactation period.

MATERIALS AND METHODS

The study included 24 goats from a local breed, aged 2–6 years, weighing 42–51 kg, bred at the clinical facilities of the Faculty of Veterinary Medicine and private farms in the Yambol and Stara Zagora districts. The animals were examined multiple times during the different stages of the lactation period. For 8 goats, the studies were performed during the first and second lactation month with the constant presence of the offspring. For the rest of the animals, which were separated from the offspring, ultrasonography was carried out during the third, fourth, and fifth month of lactation. All animals included in the study were milked manually, with all tests being performed immediately after milking and 2 hours afterwards.

Ultrasonography was performed using an Aloka SSD 500 Micrus (Tokyo, Japan, Co. Ltd) device and a linear 5 MHz transducer. Findings were documented on a thermo-video printer Mitsubishi P91 E (Tokyo, Japan).

Two examination methods were used – direct contact (transcutaneous ultrasonography) and immersing the examined organ in warm water – the "water bath" method (Stocker *et al.*, 1989). With the transcutaneous mammary gland ultrasonography, the probe was placed on the skin after application of a contact gel (Eco-super gel, Forli, Italy). In order to implement the second method, plastic cups of various sizes were filled with warm water, with the transducer being in contact with the vessel or inside it.

During the scan itself, the transducer was positioned along the length and width of the mammary gland, designated, respectively, as horizontal and vertical positions.

Initially, the echostructures of the mammary papilla were outlined – papillary orifice, teat canal, the Furstenberg's rosette, the papillary part of the cistern and the separate layers of the papillary wall. After that, the mammary lobes were examined. The parenchyma, the gland cistern and lactiferous ducts were observed.

RESULTS

During the examinations of the mammary papilla, the papillary orifice was visualized as a small anechoic formation at its tip. Directly above it, the teat canal was seen as a thick white hyperechoic line, surrounded on both sides by parallel thick hypoechoic zones (Fig. 1A). No differences between the horizontal and vertical scans were found (Fig. 1B).

The image of the mammary papilla at vertical transducer position showed that three separate layers of the papillary wall could be visualized (Fig. 1C). The outermost layer (teat skin) was seen as a light hyperechoic line. The middle layer (muscles) was homogenous and thick with moderate echogenicity (hypoechoic layer). The innermost layer (mucosa) exhibited a hyperechoic image.

The transition from the papillary duct to the teat cistern is designated as Furstenburg's rosette. By ultrasonography, it was observed as a homogenous hypoechoic structure (Fig. 1A).

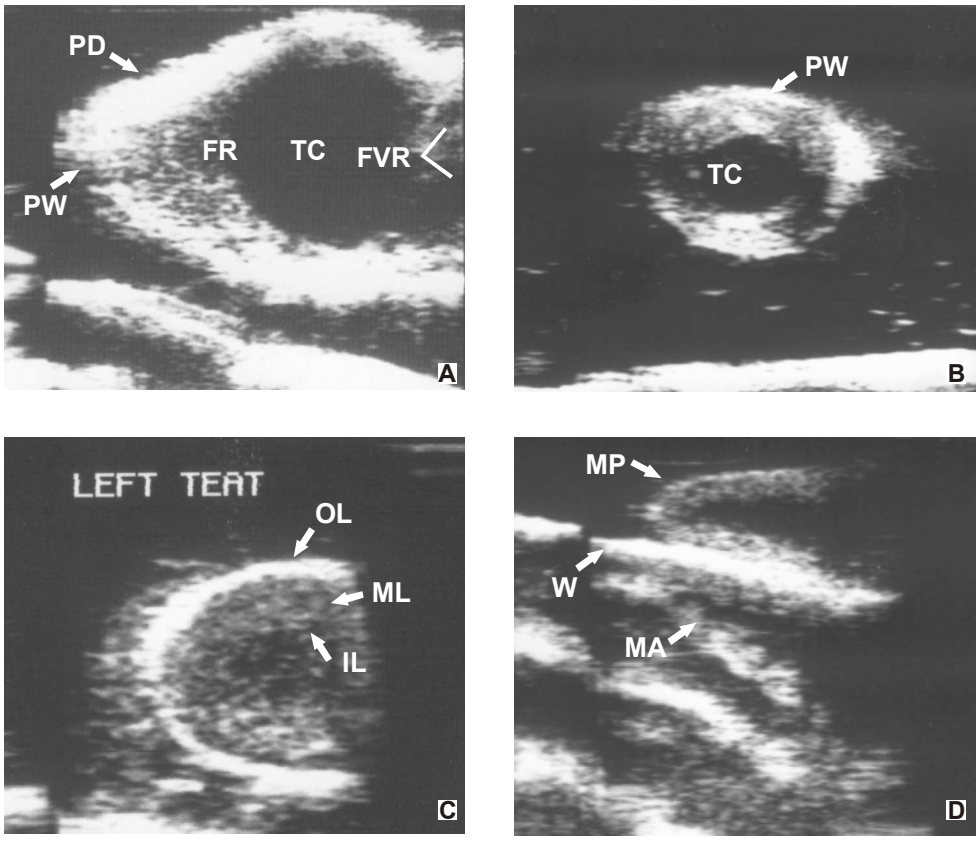

Fig. 1. Ultrasonography of the mammary papilla in a goat: A. vertical scan; B. horizontal scan; C. layers of the papillary wall; D. mirror image artifact; PD – papillary duct; PW – papillary wall; FR – Furstenberg's rosette; TC – teat cistern; FVR – Furstenberg's venous ring; OL – outermost layer; ML – middle layer; IL – inner layer; MP – mammary papilla; W – vessel wall; MA – mirror image artifact.

The teat cistern's lumen, filled with milk, was anechoic. The boundary between the gland cistern and teat cistern included large round anechoic structures – blood vessels from the Furstenberg's venous ring (Fig. 1A).

When the ultrasound transducer was immersed in warm water during the examination of the mammary papilla, the so-called mirror image artifact was produced (Fig. 1D).

Examination of the mammary gland parenchyma was performed primarily by horizontal scans. It was homogenous and appeared as a hyperechoic structure (Fig. 2A), with anechoic zones, parts of blood vessels or lactiferous ducts. The milk secretion in the cistern gave an anechoic image with single echoic particles. The large lactiferous ducts within the cisterns were clearly visible and anechoic as well (Fig. 2B).

In the animals examined during the first and second month of lactation, with a constant presence of kids, most of the abovementioned structures were always visualized. Only in several isolated cases, the gland cistern and the Furstenberg's rosette were not seen.

In goats within their third, fourth, and fifth month of lactation, kept without the kids and examined right after milking, the visualization of the papillary duct was not possible in most examinations. In other cases it was obstructed or there was no clear differentiation between the three layers of the papillary wall, Furstenberg's rosette and the lactiferous ducts in udder's parenchyma.

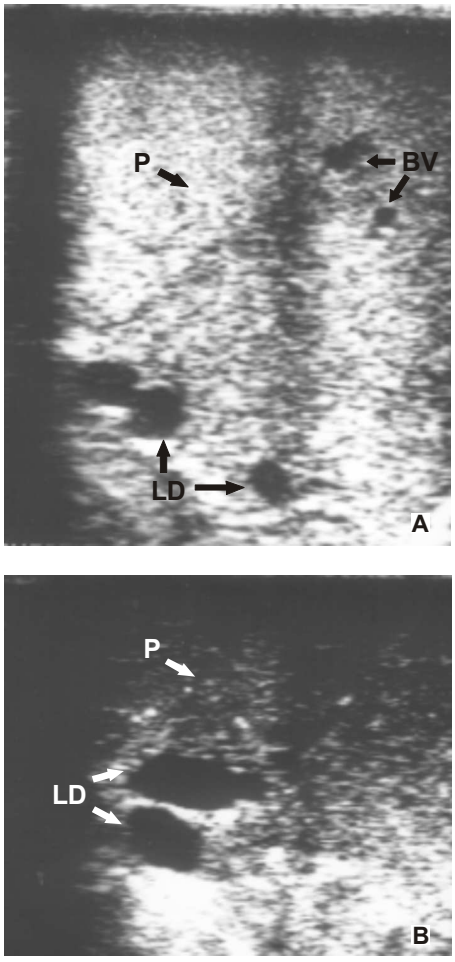

Fig. 2. Ultrasonography of the mammary parenchyma in a goat (horizontal scan): A. echostructure of the parenchyma; B. vizualization of lactiferous ducts; P – glandular parenchyma; LD – lactiferous ducts; BV – blood vessels.

DISCUSSION

Comparing our results to those of other authors who worked with different animal species, there were analogies, based on the similar anatomical structure of the udder in ruminants.

According to Will *et al.* (1990) and Saratis & Grunert (1993) when using a 5 MHz linear ultrasound transducer, the image of the papillary duct of cows has one or two visible hyperechoic lines, as also observed during our examinations of goats. Seeh *et al.* (1996) reported that an

image of satisfactory quality could be achieved via direct contact of the mammary papilla with a 3.5 or 5 MHz probe, whereas Stocker *et al.* (1989), Will *et al.* (1990), and Saratis & Grunert (1993) achieved better visualization using the "water bath" method.

Ultrasonography of the mammary gland in goats showed that the different anatomical structures were clearly visualized when using immersion in warm water or vertical transducer positioning. These results matched the findings of Santos *et al.* (2004), who established this principle during ultrasonographic examinations of cows with a 7.5 MHz linear transducer. According to Franz *et al.* (2009) the plastic "water bath" containers must be smooth in order to ensure a good contact and to conduct ultrasonic waves.

When the transducer and the mammary papilla were immersed into warm water, using vertical scanning, the so-called mirror image artifact was produced. DesCôteaux *et al.* (2010) also observed this event with a strongly reflective surface. According to them, the second image of the examined structure, designated as a mirror image, is produced below this surface.

In our belief the 5 MHz linear transducer used for transcutaneous ultrasonography of the mammary papilla did not produce satisfactory results. This is supported by the fact that the only structure observed in 100% of the examined goats was the anechoic teat cistern.

Similarly to the studies of Cartee *et al.* (1986), Güngör *et al.* (2005) and Franz *et al.* (2009), our examinations on structures of the mammary gland's parenchyma showed better results with direct contact between the transducer and the skin and horizontal positioning. The visualization of echostructures in this area is hard to perform with the water bath technique because it is uncomfortable for the operator.

The data obtained in this study proved that the lack of milk secretion impeded the visualization of the various structures. It is acknowledged that fluids play the role of an acoustic window. This necessitates separating the kids from the mother at least 2 hours before examining goats reared together with their offspring. For the rest of the animals, the best visualization could be achieved when the examination was performed at least 2 hours after the last milking. Şendağ & Dinç (1999) also achieved a better image when the mammary papilla was filled with milk or neutral solutions prior to examination. Thus they could register the structures within the lactiferous sinus of lactating cows, using 5–7.5 MHz linear transducers.

The analysis of the results points out that the usage of B-mode ultrasonography and a linear transducer at 5 MHz makes it possible to establish the echographic features of mammary glands in lactating goats. The mammary papilla is best scanned vertically, whereas the mammary parenchyma – in horizontal position of the transducer. Application of the "water bath" method is more effective when the mammary papilla is examined, and the transcutaneous method – when examining the structures in the other areas of the mammary gland. Ultrasonographic examination of the mammary gland in lactating goats should be performed at least 2 hours after separation of the kids from the mothers or the last milking.

In conclusion, the produced results could serve as a basis for future ultrasonographic research into various pathological conditions of the mammary gland in goats, with regard to more accurate diagnostics and prognostication.

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