Ultrasound measurements of teat structures in goats

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SUMMARY

The aim of the study was to determine the dimensions of teat structures in goats by ultrasonography. The experiment was conducted on 30 clinically healthy goats from a local Bulgarian breed, 2 to 8 years of age, weighing 45–60 kg. Sixty teats were examined by ultrasonography using a 7.5 MHz linear transducer and the “water bath” technique. Ultrasound measured parameters were teat canal length and diameter, diameter in the region of Furstenberg’s rosette, widest teat cistern diameter and teat wall thickness. Ultrasound scans were done during the 1st, 3rd and 5th months of lactation. The analysis of results showed that teat ultrasonography allows for a rapid and precise assessment of dimensions of the different teat structures in goats. The data obtained for the different stages of lactation showed a clear trend of reduction of teat canal length, teat canal diameter, diameter in the region of Furstenberg’s rosette and widest teat cistern diameter. The ultrasound measurement of aforementioned structures is of clinical relevance for detection of deviations in their size following pathological changes in goat’s udder.

Keywords: ultrasonography, measurement, teat, goats

Introduction

Ultrasonography is a modern method for diagnostics of various physiological and pathological systemic changes. It has witnessed a widespread use during the 1990s and today, it is routinely used in clinical veterinary medicine.

The ultrasound examination of the mammary gland was mainly applied in cattle to detect teat stenosis, proliferation, foreign bodies, milk stones and congenital teat defects [3, 6, 12]. It was also used for diagnostic imaging of mastitis, mammary gland hematomas, abscesses and tumors in animals [2, 5, 26].

Numerous research reports outline that the principal indication for mammary gland ultrasonography in ruminants was to measure various teat structures [8, 9, 15, 16, 24, 25]. The technique allows for detailed and precise measurements of teat canal length and width, the teat cistern diameter and teat wall thickness. Moreover, many authors have observed a relationship between mastitis in cattle, the stage of lactation, ultrasound features of teats and the visualisation of the teat canal [1, 11, 18, 21, 23].

In goats, udder ultrasonography has been performed with the following purposes:

- measurements of teat cistern and teat canal to establish changes occurring after machine milking [17, 19, 24, 27, 28];
- evaluation of milk yield in goats with hormone-induced lactation [14];
- determination of the possibility for visualization of the different teat structures during the lactation [4].

To our best knowledge, there are no reports on ultrasound measurements of teat structures in local goat breeds.

The purpose of this investigation was to determine the dimensions of teat structures in goats, reared in Bulgaria, using ultrasonography.

Material and methods

The experiment was conducted on 30 clinically healthy goats from a local Bulgarian breed, 2 to 8 years of age, weighing 45–60 kg, housed and fed uniformly. Goats were between first and seven lactation. The animals were reared in private goat farms in the settlements of Malenovo (Yambol district) and Gorno Alexandrovo (Sliven district).

Goats were between their 1st and 5th months of lactation, milking was done manually in the morning and the evening. The udder health status was determined through inspection, palpation [13] and California mastitis test (CMT) [20]. If any pathological changes were identified, the animals were excluded from the study.
A single ultrasonography was performed on a total number of 60 teats in the 1st (n=20), 3rd (n=20) and 5th (n=20) lactation month, 6 hours after the morning feeding using a ultrasound equipment Mindray DP-2200Vet (Mindray, China) and 7.5 MHz linear transducer. Scans were done with the water bath technique – immersion of the teat in a plastic cup with water (temperature 35ºС) and pressing the contact gel-covered probe against the outer cup surface [16].

Initially, the possibility for visualization of teat structures – teat canal, Furstenberg’s rosette, teat cistern and teat wall – was explored. Then, ultrasound measurements (Figure 1) of the following parameters were made:

• Teat canal length;
• Teat canal diameter
• Diameter in the region of Furstenberg’s rosette;
• Widest teat cistern diameter
• Teat wall thickness.

Results

The teat canal was observed as a hyperechoic line surrounded from both sides by hypoechoic areas. The Furstenberg’s rosette was seen as a hypoechoic structure at the transition between the teat canal and the teat cistern. In the teat wall, three layers were clearly distinguished – outer hyperechoic (skin), hypoechoic (muscle) and inner hyperechoic (mucosa). The lumen of the teat cistern was anechoic (Figure 2).

The mean values of studied parameters in all goats are presented in Table I. The listed dimensions corresponded to a mean teat size of 6.75 (±1.95) cm, and average lactation number of 3.86 (±1.59).

Table I: Ultrasound measurements of structures in the teat of goats included in the study (n=60)
Ultrasound measurements of goat teat structures during the different lactation months are presented in Table II.

The mean teat length was 7.3 (±2.7) cm in goats examined during the 1st month of lactation, with no statistically significant differences when compared to lengths measured during the 3rd and the 5th months (6.4 ±1.48 cm and 6.6 ±1.35 cm, respectively.

The mean teat canal length was 0.71 (±0.1) cm during the 1st, 0.64 (±0.11) cm during the 3rd and 0.54 (±0.04) cm during the 5th lactation months, with statistically significant differences (p<0.05).

The teat canal diameter was significantly higher (p<0.01) during the 1st month of lactation than during the 3rd and the 5th months of lactation.

A similar relationship was observed for teat diameter in the region of Furstenberg’s rosette and the widest teat cistern diameter. For goats in their first month of lactation, the diameter at rosette’s area (0.91±0.22 cm) and teat cistern diameter (2.14±0.5 cm) were statistically significantly higher (p<0.001) than values observed during the 3rd and 5th months.

Ultrasound measurements of teat wall thickness did not differ considerably with respect to the different lactation months.

**Discussion**

The numerous recent publications on ultrasound application for measurements of teat structures in cows, sheep and goats support the efficacy of the method and the need for continuous studies on this subject. Many researchers [8, 9, 15, 25] have used these ultrasound measurements to establish the changes in teat tissues after milking of cows. The results of GLEESON et al. [9] showed that the method could be used as a research tool to demonstrate the effect of the different milking systems on teat tissue response. Ultrasound measurements of teat canal length and diameter, teat cistern diameter, teat wall thickness could also serve to investigate the effect of teat cups, pulsator settings and the level of vacuum on tissue changes occurring in teats of lactating cows [10].

SLOSARZ et al. [24] reported a mean teat canal length of 8.6 (±0.23) mm before milking, 9.7 (±0.23) mm 4 hours after machine milking and 9.0 (±0.24) mm, 6 hours after milking (p<0.05), in Polish white goats (n=10). A similar lengthening of the teat canal was observed by OLECHNOWICZ et al. [17] in machine milked Holstein cows – from 10 mm before milking to 11.2 mm after that. These data are also supported by the studies of GLEESON et al. [9] and CELIK et al. [1] in cows. The teats of the local Bulgarian goats included in our study (n=60) exhibited a lower mean teat canal length (6.3 ±1.2 mm) than that of the study of SLOSARZ et al. [24], although the maximum value of the parameter was 9.3 (±1.2) mm.

The results during the different lactation months showed a marked tendency for reduction of teat canal length (p<0.05), teat canal diameter (p<0.01), diameter in the region of the Furstenberg’s rosette (p<0.001). In our belief, this was probably due to reduction of the amount of milk in the cistern, especially by the end of lactation and the faster milking of goats.

In concordance with our results, MELO et al. [14] established cistern size of 1.36 cm in transgenic and 2.25 cm in non-transgenic goats. According to SALAMA et al. [19],

<table>
<thead>
<tr>
<th>Parameter</th>
<th>1st month (n=20)</th>
<th>3rd month (n=20)</th>
<th>5th month (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean, (SD)</td>
<td>Mean, (SD)</td>
<td>Mean, (SD)</td>
<td></td>
</tr>
<tr>
<td>Teat canal length (cm)</td>
<td>0.712 (±0.1)</td>
<td>0.645 (±0.11)</td>
<td>0.537 (±0.04)*</td>
</tr>
<tr>
<td>Teat canal diameter (cm)</td>
<td>0.378 (±0.05)</td>
<td>0.285 (±0.04)</td>
<td>0.254 (±0.03)**</td>
</tr>
<tr>
<td>Teat diameter in the area of Furstenberg’s rosette (cm)</td>
<td>0.910 (±0.22)</td>
<td>0.609 (±0.14)</td>
<td>0.472 (±0.03)***</td>
</tr>
<tr>
<td>Teat cistern diameter at the widest part (cm)</td>
<td>2.141 (±0.5)</td>
<td>1.477 (±0.46)</td>
<td>1.296 (±0.47) a</td>
</tr>
<tr>
<td>Teat wall thickness (cm)</td>
<td>0.476 (±0.07)</td>
<td>0.519 (±0.07)</td>
<td>0.460 (±0.04)</td>
</tr>
<tr>
<td>Teat length (cm)</td>
<td>7.3 (±2.7)</td>
<td>6.4 (±1.48)</td>
<td>6.55 (±1.35)</td>
</tr>
<tr>
<td>Lactation (number)</td>
<td>3.5 (±1.96)</td>
<td>3.8 (±1.5)</td>
<td>4.3 (±1.17)</td>
</tr>
</tbody>
</table>

* Statistically significant difference among the items in the row at p<0.05
** Statistically significant difference among the items in the row at p<0.01
*** Statistically significant difference among the items in the row at p<0.001
a - Statistically significant difference between the first and second, first and third item in the row at p<0.001
SD - standard deviation

Table II: Dimensions of the structures in the teat in goats during the first, third and fifth lactation month, established by ultrasonography
the teat cisterns in multiparous goats were of larger size than those of primiparous. Also, the studied Murciano-Granadina dairy goats were able to store more milk in the cistern at milking intervals of 8, 16 and 24 hours.

With regard to the teat wall thickness, our results were also comparable to other researchers’ reports. NEIJENHUIS et al. [16] established a teat wall thickness of 0.767 cm in Holstein cows, whereas in the same breed, SEKER et al. [22] determined a mean size of 0.67 (±0.03) cm. In goats, the mean teat wall thickness reported by SLOSARZ et al. [24] was 5.02 (±0.17) mm for the left and 5.66 (±0.18) mm for the right teat 10 hours after machine milking. These results correspond largely to our data – the ultrasound measured teat thickness wall 6 hours after manual milking of goats was 0.48 (±0.06) cm, ranging within 0.33-0.67 cm.

Conclusion

The detailed analysis of results outlined that ultrasonography was a rapid and accurate method for measuring the size of teat structures in goats. To this end, the water bath technique and 7.5 MHz linear transducer are recommended.

The data obtained during the different stages of lactation, showed a clear tendency towards reduction of teat canal length and diameter, of teat diameter in the region of the Furstenberg’s rosette and the widest teat cistern diameter.

Ultrasound measurement of these structures is of significant clinical relevance for detection of size abnormalities, accompanying mammary pathological states in goats, a subject of future studies of ours.

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References