ULTRASONOGRAPHIC EVALUATION OF AGE RELATED INFLUENCE ON THE TEAT CANAL AND THE EFFECT OF THIS INFLUENCE ON MILK YIELD IN BROWN SWISS COWS

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Abstract

A total of 400 teat canals were investigated with a linear array ultrasound probe. The teat canal was observed as a hyperechogenic line at the tip of the teat. Twenty percent of the examined teat canals showed a crooked course, whereas in 80%, a linear course was observed. There was no statistically significant difference among teats of crooked teat canal and lateral aspects of teats. The mean length of teat canal was found to be 11.51±0.01 mm. It was demonstrated that the length of the teat canal and milk yield were affected by the animals’ age. The teat canals were the shortest in young cows and these cows showed the highest milk yield. On the other hand, older cows with the longest teat canals showed the least milk yield. It was concluded that the ultrasonographic examination was effective in teat canal imaging and morphological assessment. The observation of the location of the canal within teats and its course was essential.

Key words: cow, teat canal, milk yield, age, ultrasonography.

Mastitis is associated with three basic interrelated factors: environment, microorganisms, and animal individual features, such as structures of the udder and teat (16). Teat canals (TC), as one of the most important elements of the defence mechanism against infections are the first barrier to intramammary infections (20). The development of the disease depends on the pathogens passing defence line and entering the TC. The morphology and functional characteristics of the teat may have effect on udder health (21). Therefore recently, several studies on the association between the structure of teat and udder health have been given a special attention (8, 9, 18, 22).

The length and morphological structures of TC may have an effect on the development of intramammary infection. It was recorded that there was a close relationship between the predisposition to mastitis and too short or too long TC (18). The examinations of TC by ultrasound (US) are rather concentrated on the determination of TC length and diameter. Besides these parameters, it has been also considered that other characteristics of TC morphology may be an important aspect. In addition, the determination of age related influence on the length of the TC, and its effect on milk yield, will supply reliable results for the evaluation of future mammary health and yield potential. Thus, in this paper, it was aimed to determine by US the length, course, and location of the TC, the influence of the age on TC length, and the effect of canal length on milk yield in lactating Brown Swiss cows.

Material and Methods

Animals. A total of 400 teats from 100 apparently healthy Brown Swiss cows aged 2.4-10 years, in various lactation stage, kept under the same condition, fed by identical ratio twice a day, and milked twice by automatic milking system were used. The cows were obtained from Bahri Dagdas International Agricultural Research Institute of Konya. The animals were allocated into three groups. Group I contained animals aged between 2.4 and 3.9 years (n=37), group II
comprised of cows aged between 4.0 and 6.9 years (n=33), and cows of group III (n=30) were 7-year-old and older. The animals were examined in the milking parlour. No sedatives or anaesthetics were used. Before the examination, the teats were washed and dried with a disposable paper towel. Prior to US evaluation, the California Mastitis Test was carried out. The California Mastitis Test positive cows were not included into the study.

Ultrasound examination. Ultrasonographic scanning (VetScanner 480, Pie Medical, the Netherlands) of the teats were carried out in a water-filled plastic cup 30 min before milking with a 5 MHz linear array transducer. Each examination and measurement was performed by the same clinician. To prevent animals’ reactions, the temperature of water was adjusted to 35ºC. Water in the cup was renewed after each use. The teats were carefully and slowly submerged into the water. To acquire clear images, contact gel (Konix®, Turkuaz medikal kozmetik, Istanbul) was applied to both transducer and cup. The teats were scanned by longitudinal planes. Once the exact border of the teat canal was identified, the image was frozen, evaluated, and measured. The age of the animals was determined from the Konya Institute records. Milk yield of the cows was recorded in the morning and evening milking during examination days. The length of the teats was recorded three consecutive times (triplicate scans of the same teat) and the mean of the measurements was used. The length of the TC was considered as the distance between teat end and Furstenberg’s rosette.

Statistical analyses. The results are presented as means ± S.D. The results were regarded as statistically significant at P<0.05, unless stated otherwise. For all animals, numbers and ratios of the TC regarding middle or lateral location of teats with the crooked course (Fig. 1) and left-right were all recorded. The length of the TC was recorded three consecutive times (triplicate scans of the same teat) and the mean of the measurements was used. The length of the TC was considered as the distance between teat end and Furstenberg’s rosette.

In all examined teats, the TC was visualised by ultrasonography. The teat canal was observed as a hyperechogenic line on the tip of the teat (Fig. 1). Out of 400 TCs of the cows, examined by ultrasonography, 320 (80%) showed linear (Fig. 1), whereas 80 (20%) showed crooked course (Fig. 2). There was no statistically significant difference among groups I, II, and III in the location (cranial-caudal or left-right) of teats with the crooked TC. When the location of TC orifice in the teats was evaluated, it was located exactly in the middle of teat tips in 378 cows (94.5%) (Fig. 1) and on the lateral aspects in 22 cows (5.5%) (Fig. 3). No significant difference was seen in the location of TC orifice on the lateral aspects of the teats between teats (cranial-caudal, left-right teats) and groups I, II, and III.

The mean length of the TC was found to be 11.51±0.01 mm. The length of the TC of teats right cranial, right caudal, left cranial, and left caudal were 11.45±0.024, 11.42±0.024, 11.73±0.023, and 11.46±0.021 mm, respectively. The differences among the canal length of teats were not statistically significant.

The length of the TC and milk yield was affected by the animals’ age. There was a positive correlation between the length of the TC and age of the animal. The teat canal was the shortest in the youngest cows (group I) and the longest in older animals (group III). Although, the mean length was similar in groups I and II; significant differences were observed between these groups and group III (P<0.001). The milk yield was similar in groups I and II; however it was the highest in the group II and differed significantly (P<0.05) from that of the group III (Table 1).

When compared, the milk yield and length of the TC, cows that had the longest TCs (group III) showed the least milk yield. Although the animals in group II had slightly longer TCs than cows in group I, they produced a higher amount of milk (Table 1).
In cows, it has been suggested that teat traits with a high hereditary status should be taken into account in selection studies, in order to reduce mastitis prevalence (6). Moreover, there is strong correlation between teat status and udder health (9, 19). This hereditary trait of the teat and its effect on udder health made researchers concentrate on its canal structure.

Several researchers emphasise that US for teat imaging is a practical, non-hazardous, non-invasive, and reliable method (4, 13, 20, 22). In our study, it was found that linear US could be effectively and safely used for the examination of the TC. The teat canal between the ostium papillare and Furstenberg rosette was seen as linear or crooked, hyperechogenic line. Hyperechogenic image of TC may be attributable to anatomical features of the canal. The teat canal is shaped by mucosa which is a part of the outer skin pulled into the inner teat. Its structure is similar to the outer skin (5). Hyperechogenic image may be associated with this mucosal layer, because it was reported that US scanning of teat skin produced echogenic images (4).

Saratis and Grunert (17) showed that the TC could be observed as two hyperechogenic bands parallel to each other. Despite the studies of Cartee et al., (3) and Stocker et al., (20) two hyperechogenic bands of TC structure was not encountered in our study. These types of TCs can be associated with the result of where the canal is enlarged, in abnormal situations or usage of high frequency scans. So far, no reports regarding the course and status of the teat canal have been published. In the current study, TC course was crooked and twisted in 80 examined teats. Twisted course of the TC observed in the teat was also noted in all teats (cranial-caudal, left-right). This twisted course of the TC may be related to the potential effect of milking machine. It may further affect or pose a risk for the health status of the udder because the identified twisted course can affect the milk flow within the TC causing a difficult in milking. Therefore, further studies are needed to investigate the flow pattern of milk throughout the TC.

In US examination, TC orifices were not in middle line but on lateral aspects of the TC in 22 teats. As on the course of the TC, no report has been published on the location of TC orifice. These types of canal structure deviated from normal pattern may be attributable to breed and peculiar to individual animals’ anatomical/morphological nature.

Table 1
Milk yield and TC length in cows of different mean age

<table>
<thead>
<tr>
<th>Age (year)</th>
<th>Group I (n=37)</th>
<th>Group II (n=33)</th>
<th>Group III (n=30)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.09±0.05</td>
<td>4.93±0.71</td>
<td>8.59±0.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk yield (kg)</td>
<td>12.10±3.44ab</td>
<td>14.42±3.99a</td>
<td>10.88±4.88b</td>
<td>0.05</td>
</tr>
<tr>
<td>TC length (mm)</td>
<td>11.0±0.16b</td>
<td>11.1±0.09b</td>
<td>13.1±0.19a</td>
<td>0.001</td>
</tr>
</tbody>
</table>

abc: Superscripts with different letters in the same line indicate significant difference.

Discussion

Co-workers repeatedly reported that the TC length had a significant effect on the flow of milk through the TC, which may be either easy or difficult (2, 5, 10, 12). Moreover, the length of the TC with milk flow disorder may be associated with the damage in the canal (11).

Michel (12) reported that the TC length was between 8 and 12 mm in cows and the TC longer than these values could negatively affect the milking. Lopppnow (10) showed that TCs were longer in cows with hard milking in comparison to those with easy milking. The same author also reported that the TC length has an effect on milking time since in cows with a longer TC milking time was significantly longer than in cows with shorter TCs. Similarly, there was a significant difference in the length between the teat with milk flow disorder and teat without milk flow disorder (5). These authors showed that the average canal length in the teat with flow disorder was 11 mm, whereas in the healthy collateral teat it was 8 mm.

The teat canal showing shorter than normal length may negatively influence udder health. Grindal et al., (6) showed that the shorter the TC, the more the udder was at risk of mammary infection. In addition, Biederman and Hubal (2) reported that milking was difficult in Holstein cows with very short TCs and the cows were aggressive and restless during milking.

It was suggested that understanding the association between TC length and udder health in dairy cows may provide valuable advantages in terms of udder health (19). In our study, the average TC length was found to be 11.51± 0.11 mm by ultrasonography. Similar findings were reported in Brown Swiss (c.a. 12 mm) by Seyfried (18) and in various breeds (between 8 and 12 mm) by Michel (12). However, our findings differed from the studies of Geishauser and Querengässer (5), who found TCs in various breeds 8 mm long (shorter than in our study) and Klein et al., (8), who found them in Brown Swiss cows 15.7 mm long (longer than in our study). These discrepancies may be related to differences in breed, lactation numbers, and lactation stages. Indeed, Seyfried (18) showed that there was a statistically significant difference between Brown Swiss and Holstein cows regarding TC length. Later, Klein et al., (8) reported that lactation numbers had effect on TC length.

Morphological evaluation of the teat indicated that cranial teats were 5% to 10% longer than caudal teats in the same animals (14). Therefore, at various lengths of teats, the canal length can be expected to be varied. But in our study no differences in the TC length
between left-right and cranial-caudal teats were observed. Previously, Weiss et al., (21) and Klein et al., (8) reported similar data that TC length dimension was the same despite differences in teat sizes. Teat length and width measured from outside had no association with certain important characteristics such as average and peak milk flow rate (21). Thus, the evaluation of future udder health and yield potential by only outer morphological measurements can be inconclusive and the determination of TC length by ultrasonographic examination is necessary. Similarly, Klein et al., (8) reported that TC measurements could be effective for the evaluation of the udder health.

Seyfried (18) found that in acute mastitis in Brown Swiss cow, the TC was generally shorter, whereas it was longer than normal in chronic and subclinical mastitis. The same author also reported that very short TC (7-10 mm) and very long TC (17-23 mm) were predisposing factors for mastitis. In addition, the author suggested selecting Brown Swiss cows with TC length of 10-14 mm for farming purposes.

In our study, the data related to TC morphology did not include the evaluation and comparison with easy milking or mammary infection. However, Seyfried (18) advocated that there was evident correlation between predisposition to mastitis and the length of the TC (5-10 mm long and longer than 17 mm) in 70 teats (24.7%) measured in Brown-Swiss cows. The ideal TC length (around 10-14 mm) for dairy farming purposes was found to be 65% in Brown Swiss cows in our study. More studies in TC length in Brown Swiss and other cow breeds are needed. Results from these studies will be valuable criteria for easy milking and evaluation of the udder health status.

According to Seyfried’s (18) hypothesis in relation with TC length in Brown Swiss cows, these theoretical results would be understood better in the future in the studies that would be carried on about the milking facility and the risk of udder infection.

The significant effect of the animal age on TC length was determined. Hamann and Burvenich (7) reported that lactation number affected the measurements of the udder and TC, and when lactation numbers increased, the TC length increased as well. The researchers suggested that the cause of the variations in TC length is due to the exposure of the teat to mechanical effect of the milking machine. In the presented study, the cause of longer TC length in the group consisting of older animals may be due to the exposure to the effect of milking machine for more time than other groups.

The teat canal length was reported to be associated with disturbances in milking (19). In the present study, the cause of the designation of lower milk yield in group III could be a decrease in milk production potential of the animals regarding age, in addition to the older age and longer TC of the animals comprising this group. However, the milk yield in group II was designated more than it was in group I animals with shorter TC. The reason of this could be that animals comprising of group II were at lactation when their milk yield potential was at the maximum level. Animals comprising of group I were not at lactation when their milk yield level was expected to be at maximum since their number of lactation was few. It has been known that milk yield in cow increases in 2 or 3 lactations and starts to decrease with the increased number of lactation.

It was concluded that the ultrasonographic examination in Brown Swiss cows was effective in TC imaging and morphological assessment. Furthermore, observation of the location of TC within teats and its course was essential and the TC length was affected by the animal’s age and had an effect on milk yield.

References


