EVALUATION OF BOVINE TEAT CONDITION IN COMMERCIAL DAIRY HERDS: 4. RELATIONSHIP BETWEEN TEAT-END CALLOSITY OR HYPERKERATOSIS AND MASTITIS

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The teat canal is the primary physical and chemical barrier to invasion of mastitis pathogens into the udder (Hamann, 1987). Between milkings, the smooth muscles surrounding the teat duct should be contracted and the teat canal tightly closed to impede bacterial passage from the teat orifice into the interior of the gland (Nickerson, 1994). A teat-end in good condition is an important resistance factor to bacterial colonization of the mammary gland (Michel et al., 1974). Changes in teat tissue by milking, teat canal integrity, and teat tissue pliability may favour penetration of bacteria into the udder (O'Shea et al., 1987).

Veterinarians and others require a simple and reliable method for evaluating teat health in dairy herds. A complete protocol for systematic evaluation of teat condition in commercial herds is proposed by a group of international experts on teat condition (Mein et al., 2001). The new protocol includes an assessment of teat-end callosity (TEC). The evaluation of teat-end callosity is based on a research classification system. This paper covers information about the relationship between teat-end callosity and udder health.

Teat-End Callosity

After repeated milkings, changes appear in teat-end tissue, resulting in the development of a callous ring around the teat orifice. Cow factors like teat-end shape, teat position, teat length, milk production, lactation stage, and parity show a relationship with callused teat-ends (Bakken, 1981; Graf, 1982; Johannson, 1957; Michel et al., 1974; Neijenhuis et al., 2000a; Rathore, 1977; Sieber and Farnsworth, 1981, Shearn and Hillerton, 1996). As early as 1942, "eroded" teat orifices were linked to machine milking (Espe and Cannon, 1942). It is clear from more recent histological studies that the observed changes result from an increase or build up of callous tissue around the orifice rather than an 'erosion' of teat tissue or the orifice. The changes are associated with mechanical forces exerted by vacuum and the moving liner during machine milking. The magnitude of the force depends on milking vacuum, pulsation vacuum, machine-on time, liner type and teat shape (Ebendorff and Ziesack, 1991; Hamann, 1987; Mein and Thompson, 1993; Rasmussen, 1993). The huge variation in the frequency of callosity between herds using similar milking systems suggests that a major genetic influence to susceptibility should not be overlooked (Shearn and Hillerton, 1996).

Classification System

Teat-end callosity can be classified visually. Several systems have been developed (for example Sieber and Farnsworth, 1981, and more recently Shearn and Hillerton, 1996). The classification system adopted in The Netherlands includes marked differences in the thickness of the callosity ring (TECT), which is transformed to five classes: none (N), slight (A), moderate (B), thick (C) and extreme (D). Average TECT of teats was calculated by using the unit scores from 1 to 5. Additionally the ring is classified as smooth (1) or rough (2) (Neijenhuis et al., 2000a). This system is proposed by the "Teat Club International" for research purposes (Mein et al., 2001).

Microscopic Features of Teat-End Callosity

There is a good similarity between the macro- and microscopic ranking of the teat-end callosity rings. Teat-end callosity consists of a hyperplasia of the stratum corneum (Neijenhuis et al., 2000b). Thicker callosity rings show parakeratosis and nuclei are evident. Teats with thick and rough teat-end callosity score show perivascular reactions such as infiltration of lymphocytes, granulocytes or erythrocytes. With thick callosity, the outside portion of the teat canal might not close tightly and micro-organisms may penetrate further into the canal. The surface of the callous ring can become rough (category 2). Rough callosity may provide crevices for pathogenic bacteria to lodge, thereby making successful teat disinfection more difficult and increasing the risk of new intra mammary infection.

Intra mammary Infection

Severe teat-end lesions (scabs) are associated with a higher prevalence of subclinical mastitis and bacterial colonization (Sieber and Farnsworth, 1981; Jackson, 1970; Fox and Cumming, 1996). For the past 20 years, it has been widely accepted that the presence of chronic smooth or rough rings on teat-ends is not associated with a significant increase in risk of mastitis (Sieber and Farnsworth, 1981). However, results of two new studies provide a different perspective.

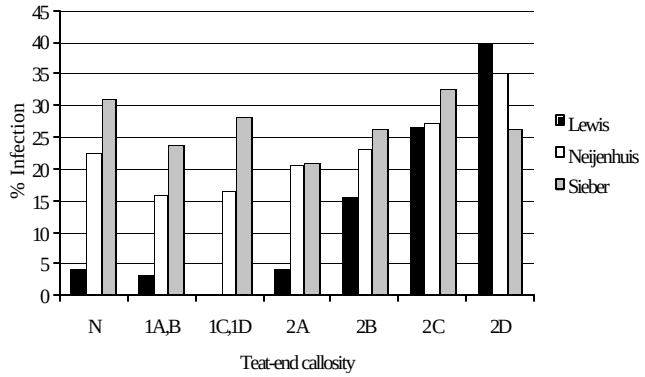

Figure 1. *Percentage of quarters infected in 3 different studies according to the teat end callosity (raw data).*

In the first study, data from the Netherlands indicated a significantly lower risk of clinical mastitis in quarters with teats classified as having mild or moderate smooth rings compared with teats classified as having no ring or rough rings (Neijenhuis et al., 2000a). Cows suffering clinical mastitis had higher TEC scores than their healthy peers, particularly when clinical mastitis occurred between the second and fifth month of lactation. The second, smaller study

(2000 quarters) in the UK showed a similar trend of increased risk of sub-clinical mastitis (inferred from CMT score) with poorer teat-end scores (Lewis et al., 2000).

As shown in Fig 1, this same pattern of results can be seen in the original data of Sieber and Farnsworth (1981). Although not significantly different, the percentage of quarters sub-clinically infected in that USA study was numerically lowest for teats with mild smooth chronic rings compared with either no rings or moderate/severe rough rings.

In drawing attention to this pattern, which also appears to match the model proposed by Hamann (1987), we are not suggesting that a smooth ring around a teat orifice will have any clinical benefit *per se*. Clearly, the integrity of the teat canal lining and the teat orifice are the keys to minimising the risks of mastitis infection. Perhaps the presence of a smooth ring is associated with a mild thickening of the keratin seal and underlying germinal layers of skin in the teat canal and teat orifice. Mild hyperplasia is a basic (normal) physiological response to the forces imposed by milking. Under the correct milking conditions, it may reflect a healthy balance between the degree of desquamation per milking and the rate of regeneration of keratin within the teat canal (Williams and Mein, 1985; Lacy-Hulbert, 1998).

Unpublished data from the USA (pers. comm. S.P. Jones and J. Britt, 2001) from one large farm also showed increased risk of clinical mastitis and higher SCC for cows with one or more "bad" teat-ends compared to cows with 4 healthy teat-ends. "Bad" teats had a score of 3 or more according to the system of Britt and Farnsworth (1996).

Longitudinal Field Study

In a Dutch study (Neijenhuis et al., 2001), 57,762 teat-end scores were eligible to compare teat-end score with the probability of clinical mastitis. The probability of clinical mastitis in the month following that TEC observation, 974 records were selected. Because teat-end shape, days in milk and parity are known to influence the TEC, all these factors were included in the model.

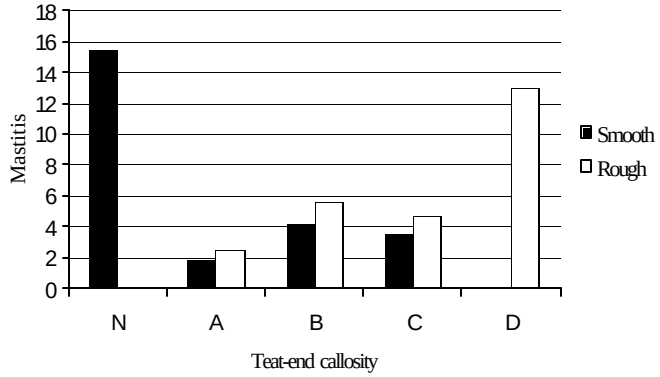

Figure 2*. Probability of clinical mastitis (%) of second parity cows in the beginning of the lactation with pointed teat ends for different teat end callosity scores.*

Roughness of the teat-end callosity during the lactation increased with the probability of clinical mastitis. Cows with smooth callosity rings had a probability of clinical mastitis the next month of 1.4% compared to 1.9% for cows with rough callosity rings. The mean probability of clinical mastitis was 3.8% for no callosity ring, 1.5% for a thin, 1.8% for a moderate, 2.7% for a thick and, 2.9% for extreme thick callosity ring. Because of the interaction between teat-end callosity thickness, lactation stage and teat-end shape, data were analysed for a specific lactation stage and

teat end shape. Figure 2 shows an example of the probability of clinical mastitis for different teat-end callosity scores. It appears that teat-ends with no callosity ring are more susceptible if they are pointed rather than inverted. Inverted teats are more at risk when the callosity ring is thick. The probability of clinical mastitis decreases as lactation progresses.

Conclusion

A small amount of teat-end callosity does not appear to increase the risk of intra-mammary infection in the lactating dairy cow, and may be considered as a beneficial physiological response of the teat to machine milking. A greater degree of teat-end callosity and roughness is associated with an increased probability of new intra-mammary infections. Evaluation of teat-end callosity in commercial herds may help to identify or resolve problems related to milking management, environment or the milking machine.

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