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Effect of over-milking on teat condition

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Unsatisfactory milking conditions, including high milking vacuum, ineffective pulsation, heavy clusters, unsuitable liners, poor teat preparation and over-milking, are known to create poor, but undefined, teat conditions and pose a risk to an increased probability of intramammary infection (IDF, 1994). It has been shown that poor teat condition, seen as discolouration, abnormal firmness or thickened rings of tissue distally, after cluster removal may be common in a variety of commercial milking operations (Hillerton *et al.* 2000). That field study was observational and teat conditions were influenced by a number of variables. A small experimental study has been undertaken to develop an experimental model, under controlled milking conditions, to allow investigation of potential causes of teat trauma. Over-milking was suggested as highly important in the field observations and so has been examined in this study.

materials and methods

Six mid-lactation Holstein cows from the dairy herd at the Institute for Animal Health were milked for 4 days in each of 3 successive weeks in an experimental parlour using one of three specified milking clusters. During the 3-week trial all cluster assemblies used a DeLaval HC150 claw, 14-mm long milk tubes, 60 cycles per min pulsation using a ratio of 65%, and milking using a system vacuum of 47 kPa, with no milk lift.

On the first day of each week, all clusters were removed by automated cluster operation at a flow rate of 200 ml/min with a delay of 10 s. On each of days 2, 3 and 4, two cows each day had the cluster removed automatically 10 s after a flow rate of 200 ml/min was detected. This is a typical commercial setting for this type of plant in the UK and reflects no over-milking. Another two cows had removal delayed by 2 min after the removal was triggered. The final two cows had removal delayed by 5 min. This gave different amounts of over-milking. The milking conditions were varied through the 3 d in a Latin square design so each cow experienced each degree of over-milking.

In the first week, the cluster was fitted with DeLaval 960000 liners in DeLaval 960550-85 shells giving an average cluster weight of 2·8 kg. In week 2, Dairymaster 916S liners in Dairymaster shells were used giving an average cluster weight of

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3·2 kg. In week 3, Surge 10025 liners in Surge shells were used giving an average cluster weight of 2·3 kg.

Teat conditions, including length and width, were scored immediately before cluster attachment and within 30 s of cluster removal for all cows for each milking condition applied, as described by Hillerton *et al.* (2000). Independent assessments of teat condition were made by any two of the three authors both before and after milking. Data on colour and feel were assigned to categories normal (no change) or abnormal (discoloured or firm/hard) and scored 0 or 1. Data on teat ringing were scaled as appropriate to severity and were scored as 0 (no change), 4 (visible mark only) or 10 (thickened ring). Analysis of variance, using Genstat 5 release 4·2 (Lawes Agricultural Trust, 1997), was used to determine any effect of time of over-milking, liner type and any interaction between these variables.

RESULTS

An average increase in teat length of 5 mm during milking was observed. This did not appear to vary with the conditions used. No measurable changes in teat width were observed, irrespective of liner type or degree of over-milking.

Typical changes in teat condition are shown in Fig. 1 and variations in frequency of teat conditions with the liner and degree of over milking are given in Table 1. The degree of colour change was variable between cows but usually consistent between teats within cow. The ringing at the base of the teat was always very obvious and associated with the tissue within the mouthpiece chamber of the liner. The firmness of the teat was obvious by gentle squeezing and usually predictable by visual observation that the teat was swollen, seen in the photographs as unfolded skin and a shiny appearance. All teats of all cows, whatever treatment was applied, appeared normal before cluster attachment. Casual observation showed that the changes were relatively short-term resolving within 2 to 4 h after milking.

When the clusters were removed automatically at the end of milk flow, when no over-milking was applied, approximately one-third of all teats were visibly redder than seen before milking (Table 1). This occurred irrespective of cluster type. Similarly, there was no statistical difference between the liner types after 2 min of over-milking although the proportion of teats red or more discoloured increased to 50 % for the 960000 liner, to 67 % for the 10025 liners and to 83 % for the 916S liners. With 5 min of over-milking a higher proportion of teats was discoloured, 75 % for the 960000 and 10025 liners and 92 % for the 916S liners. The difference between liner types was not significant but there was a significant difference ($P = 0{\cdot}003$) with time.

Ringing at the base of the teat, involving tissue within the liner mouthpiece chamber during milking, was totally absent on all teats before milking but only absent on fewer than 12 % of teats after milking, with no over-milking, irrespective of liner. A palpable 'garter mark' or ringing of the teat barrel was observed with no over-milking on 42 % of teats milked with the 960000 liners, 58 % milked with the 10025 liners and 75 % milked with 916S liners. There was pronounced tissue thickening on some teats with all three liners after cluster removal. With 5 min of over-milking 92 % of teats had palpable rings of tissue, often up to 10 mm thick and quite firm, whatever liner type was used. There was a significant increase in the proportion of teats with palpable ringing with an increasing amount of over-milking ($P < 0{\cdot}005$).

The greatest variation in response of teats to over-milking occurred with the most

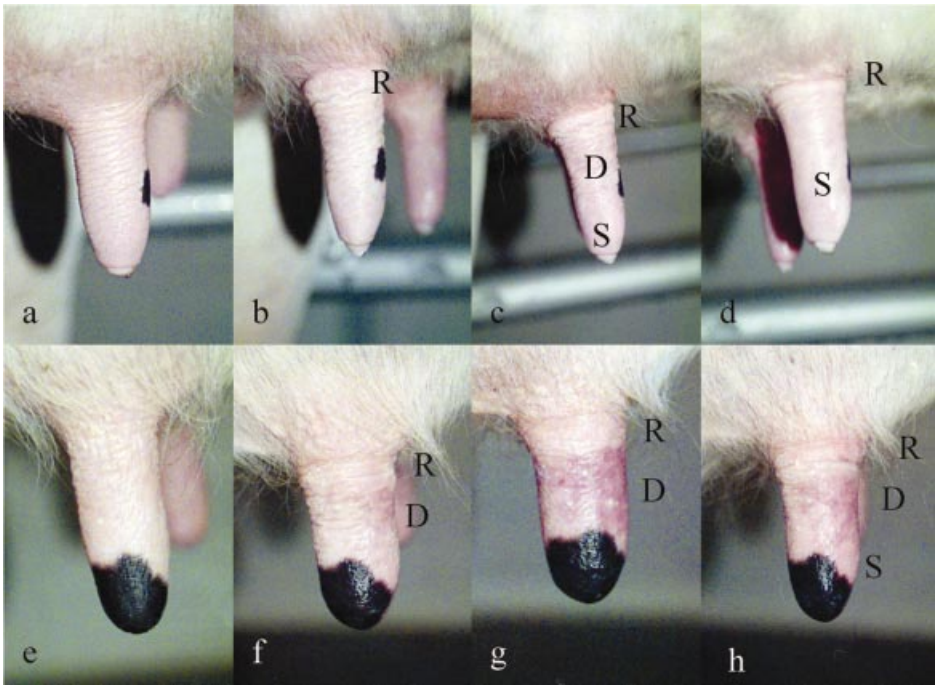

Fig. 1. Examples of the teat changes scored. Right front teats are shown of two of the six cows, before milking (*a* and *e*), after no over-milking (*b* and *f*), after 2 min of over-milking (*c* and *g*) and after 5 min of over-milking (*d* and *h*). D – discolouration; R – ringing; S – swelling indicating firmness.

Table 1. *Number of teats scored normal or abnormal for the three parameters with three different liners and three degrees of over-milking* ($n = 24$)

	Liner								
	960000			916S			10025		
	Over-milking (min)								
	0	2	5	0	2	5	0	2	5
Number of teats									
Colour									
Normal	16	12	6	18	4	2	18	8	8
Discoloured	8	12	18	6	20	22	6	16	16
Ringing									
None	4	4	0	2	3	2	2	1	0
Visible	10	6	2	4	3	0	8	7	2
Palpable	10	14	22	18	18	22	14	16	22
Touch									
Normal	24	24	19	16	4	4	16	4	0
Firm or hard	0	0	5	8	20	20	8	20	24

subjective assessment, the change of feel for firmness or hardness. Firmness or hardness was infrequent with the 960000 liner. No teats were affected when there was no over-milking and only 20 % of teats were scored as abnormal after 5 min of over-milking using this liner. Approximately 33 % of teats appeared firm when milked with either the 916S or the 10025 liners with no over-milking. This increased to 83 % and 100 % respectively when 5 min of over-milking was applied. The differences between liners and with time were highly significant ($P < 0{\cdot}001$).

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DISCUSSION

The significance of the types of changes induced is unclear. Discolouration, but not extending to bruising, was short-term and presumably caused by exposure to sustained vacuum. It is likely that the average level of vacuum was higher in the over-milking period as there was no milk flow to dissipate system vacuum and thus, the changes were more frequent and greater with over-milking. Repeated experience of such conditions may induce progressive capillary damage. The ringing of the base of the teat was shown by Newman *et al.* (1991) to be caused by a sustained vacuum in the mouthpiece chamber of the liner, unrelieved during most of the milking time. Over-milking would extend this period by a significant amount. The firmness of the teat is a more difficult change to explain. It is likely to be caused by an accumulation of fluids in the teat and is suggestive of impaired pulsation. The pulsation characteristics were the same for each liner but the responses of the liners not necessarily similar. The 10025 liner, which induced most firmness with over-milking, has a narrower bore and so may not have created as much compressive load and collapsed as fully when the teat started to accumulate fluid. The effect may have been reinforcing. The changes reported are very obvious after milking and, although their pathological consequences are unknown, intuitively they appear unacceptable as indicating diminished welfare of the cow. This is supported by observations of similar teat conditions in commercial dairying and that over-milking results in more agitated cows (Hillerton *et al.* 2000).

This preliminary investigation contained a number of variables, unusual under normal and recommended commercial uses of the three different liners. The study only used a limited number of cows for a short time yet the changes in teat condition were easily observed and clearly differed with liner and degree of over-milking. The small scale of the trial does require some caution in interpretation although these changes reflect field observations on many cows (Hillerton *et al.* 2000). The conditions used were most suitable for the DeLaval 960000 liner perhaps explaining why it induced the fewest changes in teat condition. Milking at 47 kPa was higher than the recommended vacuum for the 960000 and the 10025 liners and so may have led to poorer teat conditions with these liners. It is clear that all teat conditions examined were worsened, irrespective of liner type, when over-milking was allowed. It appears obvious that best milking practice should include only use of recommended combinations of milking cluster components, recommended milking conditions including vacuum level and pulsation, and avoidance of over-milking. The avoidance of over-milking is especially important with certain milking conditions, and probably at all times.

Experimental investigation of the causes of changes in teat condition during machine milking is incomplete but this preliminary study shows that examination of teat conditions after milking is a useful indicator of the suitability of milking clusters and their operating conditions. Further trials are being undertaken to determine guidelines for milking factors likely to compromise teat health and thus animal welfare.

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