Influence of the duration of a and c phase of pulsation on the milking characteristics and on udder health of dairy cows

P. Billon[1] & V. Gaudin[2]

[1]Institut de l'Elevage, B.P. 67, 35 652 Le Rheu Cedex, France
E-mail: pierre.billon@inst-elevage.asso.fr

[2]Ferme expérimentale de Derval, 44590 Derval, France

Summary

Two experiments were carried out at the experimental farm of Derval (France) in order to study the influence of the duration of the a and c phases of pulsation on the milking and udder health of dairy cows.

The first experiment compared (in a Cross-over experimental design) three durations of a and c phases (a = 13, 15 and 22 % and c = 8, 12 and 16 % of the pulsation cycle) at three vacuum levels (39, 42 and 42 kPa). The experiment lasted 3 periods of 6 weeks during which milk ejection parameters were recorded.

The second experiment compared two groups of animals, the first one milked with the following phases: a = 14 and 23 % (adjustment A) and c = 9 and 15 % (adjustment B) during 5 months. Udder health parameters were essentially recorded: clinical mastitis, somatic cells counts and teat end conditions.

Milking time and milk flow rates are the parameters widely dependent on the duration of a and c phases. The shortest phases produced the longest milking times (+ 4.7 up to +10.1%) and the lowest flow rates (- 3.3 up to -7.8%).

Neither of the two experiments showed a marked effect of the duration of a and c phases on udders health and teat end conditions were also relatively similar to the different treatments. A small tendency was found in which teat end conditions were worse especially those cows with sharp teat ends shapes when they were milked with the shortest phases.

A c phase of 12 % and an a phase of 14-16 % of the pulsation cycle should be a good compromise in order to avoid increasing milking times and to prevent any sanitary problems, with the current liners vacuum levels.

Introduction

Pulsation is well known to be one of the most important elements of milking machines which has a great influence on milking and on udder health. Many scientific studies and a lot of field observations have shown that pulsation failures are directly implicated in mastitis and high somatic cell counts.

The main pulsation parameters are the frequency, the ratio, and the four phases, (a, b, c and d) as described in ISO 3918 (1996). ISO Standard 5707 (1996) specifies that "*phase b shall be not less than 30 % of a pulsation cycle. Phase d shall be not less than 15 % of a pulsation cycle and shall be not less than 150 ms*". However, a and c phases are not included in the above mentioned ISO Standard especially because of a lack of scientific results on their influence on the milking and udder health of dairy cows.

In France some field technicians and farmers advisers think that too short a and c phases, but especially the c phase, are involved in udder troubles and particularly clinical mastitis and high somatic cell counts.

Therefore, two studies were undertaken in an experimental farm in Derval (France) in order to investigate the effects of a and c phases duration at different vacuum levels on the milking and udder health of dairy cows.

Materials and methods

The first study was carried out in a tunnel parlour with 3 stalls and 3 units in low line and 27 cows were used in a Cross-Over experimental design. Pulsation rate was 60 cycles/min and pulsators ratio 60%. Three a and c phases were studied:
- adjustment 1: a = 13 % and c = 8 %;
- adjustment 2: a = 15 % and c = 12 %;
- adjustment 3: a = 22 % and c = 16 %),

all at three vacuum levels: 39, 42 and 45 kPa.

Three groups of 3 cows were milked during 3 periods of 6 weeks with the three adjustments and each vacuum level.

Milking units were Harmony clusters from DeLaval with the liner number: 999007-03. Pulsation parameters as a and c phases were adjusted by a special device at each unit. All parameters were checked before the beginning of the study and between each period.

The recorded parameters were the following: total milk yield, machine milk yield, machine stripping yield, total milking time, machine milking time, stripping time, average and maximum milk flow rates. These parameters were recorded 4 times a week (2 in the morning and 2 in the evening). Once a week teat end thickness before and after milking were measured with a cutimeter (Haupner) and somatic cell counts for each cow were analysed.

The second study was carried out in the herringbone milking parlour of the experimental farm 2 x 5, 10 units in low line and lasted 5 months. Two groups of 20 cows, matched for number and stage of lactation, milk yield and SCC, were milked twice a day at 41 kPa and a pulsation rate of 60 cycles / min and a ratio of 60 %. The first group was milked twice a day with a and c pulsations phases respectively of 14 % and 9 %, and the second group respectively of 23 % and 15 %. The recorded parameters were: SCC once every two weeks, teat end thickness before and after milking and teat end conditions twice a month.

Results

All data analysed in experiment 1 with the 3 vacuum levels together do not show any statistical difference on total milk yield (TMY), machine milk yield (MMY) and machine stripping yield (MSY). TMY was around 26,3 litres / day for each adjustment, MMY around 25.7 l / day and MSY around 0.60 l / day.

On the contrary, statistical differences were found for total milking time (TMT) and machine milking time (MMT) but not for machine stripping time (MST) (Table 1).

Because cows milked at different vacuum levels were not exactly matched on milk production before the experiment, we could not compare milk yield between each vacuum level. It was only possible to study the influence of the three adjustments at each vacuum level.

Table 1. Milking times during experiment 1 (seconds/cow/day).

Adjustment	1	2	3
TMT	736,9 ^{a}	716,7 $^{a\,b}$	707,7 ^{b}
MMT	670,6 ^{a}	648,4 $^{a\,b}$	631,8 ^{b}
MST	66,3 ^{a}	68,3 ^{a}	70,9 ^{a}

Values with different letters within the same line indicate significant differences (P<0.05).

When a and c phases were decreased from adjustment 3 to adjustment 1, TMT and MMT respectively increased of 4.1 % and 6.1 %. The same tendency was found when analysing results at each vacuum level (Table 2).

TMT and MMT had a bigger increase with the lower vacuum levels. For example, MMT raised from 11.2 %, 8.7 % and 6.4% respectively at 39, 42 and 45 kPa between adjustment 3 and adjustment 1 .

Table 2. Total milking times (TMT) for each vacuum level (seconds/cow/day).

Vacuum level (kPa) Adjustment	39	42	45
1	767,4 [a]	748,1 [a]	695,0 [a]
2	748,1 [a b]	729,1 [a b]	695,9 [a b]
3	695,0 [b]	700,2 [b]	663,8 [b]

Values with different letters within the same column indicate significant differences ($P<0.05$).

Raising milking times when milk yield does not vary in the same proportion means that the short phases have a negative effect on average flow rate (AFR) as shown in table 3. They also have the same tendency on the maximum milk flow rate (MAXFR) at different vacuum levels but no significant differences were found. MAXFR decreased from respectively 3.3 %, 7.8 % and 6.4 % at 39, 42 et 45 kPa. The effect seems bigger at the higher vacuum levels.

Table 3. Flow rates in experiment 1 (litres/min).

Adjustment	1	2	3
AFR	2.319 [a]	2.425 [a b]	2.488 [b]
MAXFR	3.704[a]	4.242 [b]	3.942[b]

Values with different letters within the same line indicate significant differences ($P<0.05$).

SCC were recorded during both experiments but neither in experiment 1 nor in experiment 2 were any significant differences found. It seems that there is no specific relationship between udder infection and duration of the a and c phases of pulsation. in experiment I SCC vary 93 000 and 139 000 the adjustment and the vacuum level. Similar results were noticed in experiment 2 (Figure 1).

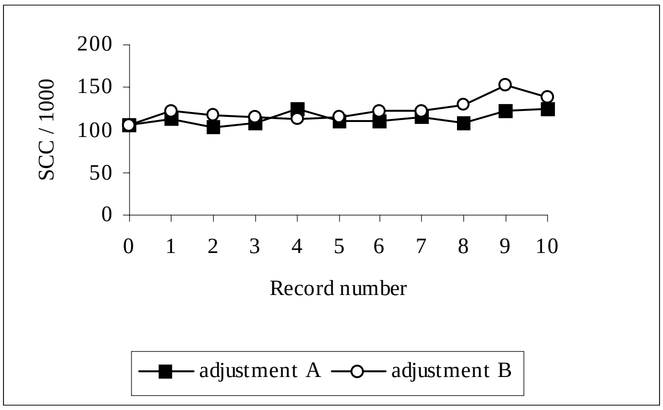

Figure 1. Evolution of SCC of the two groups of animals in experiment 2 (geometric means).

Changes in teat end thickness (relative to pre-milking thickness) were not statistically different between the 2 groups of animals in experiment 2. We only noticed that the difference is higher (softer teats?) when cows are milked with the longest phases between record 3 and 8. In addition, the number of teats with differences (after – before milking) equal or more then 5 %, suggested as an acceptable limit before high sanitary risks (Zeconni and Hamann, 1992), was similar in the two groups of cows (72 with short phases and 74 with long phases).

During experiment 2, teat end conditions were assessed for two teats (one front and one rear) as following: 0 = good conditions (normal teats) to 6 = very bad conditions (subcutaneous haemorrhages, hyperkeratosis, sphincter eversions, congestion and oedema).

In average teat end conditions were good, between 1.5 and 2.3, and similar in the two groups of cows. However, a significant difference was found only for the front teat for cows milked with the shortest phases as shown in figure 2.

Discussion

Milking time and milk flow rates are the parameters widely dependent on the duration of a and c phases. Results obtained by various authors are very similar to ours (O'Shea, 1983, Rosen *et al.*, 1983, Neijenhuis *et al.*, 1999). Comparable results found in different milking conditions indicate the existence of a relationship between milk flow rates and duration of a and c phases. The shorter the phases, the lower the flow rates and the longer milking times are.

In our study, teats stimulation was good and vacuum under teats was controlled during the experiment. However, it is possible that short phases induced animals reactions (pain and/or discomfort) because of faster

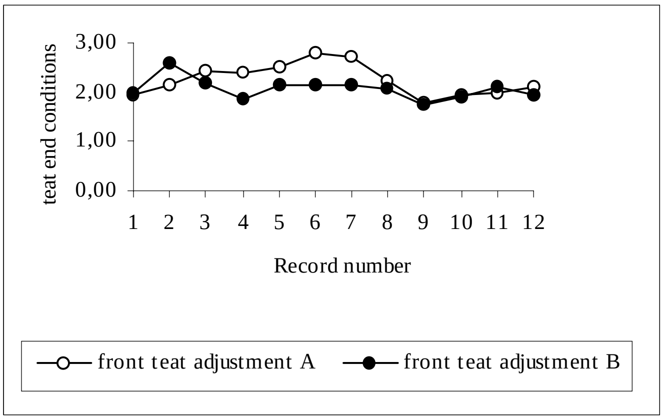

Figure 2. Teat end conditions of the front teat during experiment 2.

movements of the liner and then a certain degree of congestion. Neijenhuis (1999) observed that animals were more nervous on the platform when they were milked with short a and c phases with a small reduction of the diameter of the steak canal and a significant increasing of the teats wall thickness.

Nevertheless, neither of our two experiments showed a marked effect of the duration of a and c phases on udders health and teat end conditions were relatively similar to the different treatments. A tendency was found in which teat end conditions became worst especially for cows with sharp teat ends shapes milked with the shortest phases.

We also have to say that the two experiments were carried out with healthy cows and that experiment 2 lasted only 5 months.

Conclusion

The a and c pulsation phases are surely involved in the liner movements and compressive loads applied by the liner on the teat. Loads particularly depend on the shape, the internal diameter of the barrel and the flexibility of the liner, milk flow rate and pulsation characteristics and the teat itself. Investigations should be made on liner movements related to the studied phases in order to obtain more precisions on their action on milking and udder health.

In any case the two experiments did not produce any proof that milking with short a and c phases will automatically increase clinical mastitis, SCC and damage teat end conditions.

A final proposal with a c phase at 12 % and an a phase at 14-16 % of the pulsation cycle should be a good compromise in order to avoid to increase milking times and to prevent any sanitary problems, with the current liners and at vacuum levels within the range of 39 – 44 kPa.

References

Neijenhuis F., De Boer P., Hospes P. and Klungel G., 1999: snelle overgangsfassen pulsatiecurve leiden niet tot sneller melken. In Veehouderij Techniek. maart / april 1999. 30-31.

NF ISO 3918, 1997: Milking machines installations: Vocabulary. 26 pp.

NF ISO 5707, 1997: Milking machines installations - Construction and performance, 39 pp.

O'Shea P., O'Shea J., O'Callaghan E. and Gonzalez Arreas A., 1983: Effect of varying pulsation chamber vacuum phase on milking characteristics. In milking machine Research at Moorepark (An Foras Taluntais).

Rosen M.B., Caruolo E.V. and Mochrie R.D., 1983: Relationship of pulsation rate, pulsation ratio and vacuum decrease time to milking performance. J Dairy Sci. 66: 2580-2586.

Zeconni A., Hamann J., Bronzo V. and Ruffo G., 1992: Journal of Dairy Research. 59: 265-271.