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Performance differences and cow responses in new milking parlours

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The International Standards Organization (ISO) produces international standards for milking equipment. These describe the minimum specifications of design, installation, maintenance and testing of milking machines (BS ISO, 1996). Often these standards are adopted and exceeded by national standards. Standards are rarely mandatory and in some countries variations in interpretation and even disagreement can lead to differences in operating conditions of the milking machine.

A survey of plant test results in the UK (Berry & Scrivens, 1997) showed that, on annual or biannual testing, more than 75% of plants failed to meet the then existing standard (BS5545, 1988). In the UK, most types of plant installed since 1994 meet the newest ISO standard (BS ISO, 1996). However, one type of plant has many features different from all other types. This is a type of plant whose major variations include a smaller claw bowl volume (150 ml), a narrower long milk tube diameter (13·5 mm), 8 mm milk pulse tube, greater cluster weight (approximately 3·5 kg) and simultaneous pulsation used on a plant with milk lift and milking at an installed system vacuum of 47–48 kPa. The majority of parlours installed with this equipment at the time of this study had no form of indexing (see below).

A study has been undertaken to assess 20 new installations for compliance with the ISO requirements (BS ISO, 1996), performance in a static test, milking performance, cow behaviour and the effects on teat condition. Compliance to standards and static test results have been reported elsewhere (Ohnstad, 1997), with no plant proving entirely satisfactory. Some plants had major problems with vacuum level, pulsation characteristics and large air leaks. The physical operation of the milking plant has important implications for cow behaviour and welfare and also ergonomics of the milking operation. The effects on teat condition have already been reported (Hillerton *et al*. 2000). Here the effects on cow behaviour and milking performance are assessed. Comparisons have been made in line with the International Dairy Federation recommendations (IDF, 1997) to examine the performance and interactions of the cow, the machine and the operator in evaluating the milking process.

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Materials and methods

Agreement to co-operate was obtained from twenty dairy farms, selected at random from lists of recent installations made available from various sources, to allow inspection of the plant and milking routine within 6 months of installation and a second visit 6 months later. All of the milking machines were intended to be compliant with the new ISO standards although installation was earlier than publication of the standard. Twelve of the plants had a more common type of cluster (weight always less than 3·2 kg) with a large claw bowl volume, 15–16 mm diameter long milk tube, 10 mm minimum diameter short milk tube, used alternate pulsation and milked with a system vacuum of 41–47 kPa. They were fitted with automatic cluster removers (ACR) that were always used. The other eight plants were of the alternative type, described here as a heavier cluster, using a smaller claw bowl volume (150 ml), a narrower long milk tube diameter (13·5 mm), a narrower short milk tube (8·5 mm), greater cluster weight (approximately 3·5 kg) and simultaneous pulsation on a midi-line plant milking at an installed system vacuum of 47–48 kPa. They had no ACR.

On the first visit, a full static test to assess compliance with the standard (BS ISO, 1996) was performed, the plant was fully inspected and the whole of an afternoon milking observed. Following the first visit all farmers received a verbal and a written report of any maintenance problems or major faults. On the second visit, 6 months later, full inspections were made of 14 of the plants and full observations made of the performance during an afternoon milking on all 20 farms. Only the performance results for the second visit are reported here. Under these conditions all farmers had been given the opportunity to bring their parlour to the required standard. However, this only happened for a few selected items and on a few farms (Ohnstad, 1997) with all farmers ignoring some of the reported faults. The assessments reported are, therefore, for parlours operating to the farmer's selected criteria and reflect 'normal' operating conditions and application of the standards in practice.

Performance assessment comprised scoring of various parameters on a basis of zero (could not be better) to three (of no effect or could not be worse). Parameters evaluated were cow entry, cow standing position in the parlour relative to the milking unit, cluster hanging position during milking with respect to twist and tilt from the vertical, cow behaviour during milking (from the amount of dunging/urination to the frequency of paddling/stepping and attempts to kick off the cluster), cow behaviour during teat inspection after cluster removal, completeness of milking (assessed by amount of milk removable by hand stripping from front and hind teats) and cow exit. Scores were not allocated to individual cows but on a whole herd basis according to the overall impression. The scores were made by two observers independently and then agreed after milking. A much fuller teat assessment was also made (Hillerton *et al*. 2000).

Data from 18 of the parlours were used initially. Two sets of data were excluded as they were from parlours using mixtures of components with the more common type of cluster. With two exceptions, the heavier clusters were used in parlours with no indexing of cow position and the more common type of clusters was used always in parlours with indexing. Indexing is some physical indicator of preferred cow standing position, and may affect many of the parameters evaluated in this study. It varied from a kinked rump rail fixing the position of the hindquarters, to head yokes and to single stall tandem arrangements. Parlours with no indexing had no obvious indicators of preferred cow standing position, being fitted with straight breast and rump rails and no feeding positions, so allowing 'free' cow standing position with cows standing at 80–90° to the operator. The effects of cluster position and indexing could not be separated, and, therefore, the further two parlours which were atypical and used common clusters without indexing were also excluded from analyses of behaviour and performance in the parlour. This left 9 replicates with the more common type of cluster and indexing and 7 replicates with the heavier cluster and no indexing.

Data were analysed by one-way analysis of variance (ANOVA), with cluster/index as treatment, with 14 residual degrees of freedom (Minitab, 1995). The effect of using inducement (either by a crowd gate or in-parlour feeding) to encourage cows to enter the parlour was also evaluated by one-way ANOVA. Two-way ANOVA with factors parlour type and inducement was not used, as the design was not balanced in this respect.

RESULTS AND DISCUSSION

Parlours with the heavier clusters and no indexing scored better with respect to less liner slip and better milking out of cows (Table 1). The differences were not statistically significant but were apparent to casual observation. Limiting liner slip is a design claim for the liner used in the heavier cluster. One consequence is a higher vacuum in the liner mouthpiece and this leads to significant congestion of the teat tissue within the mouthpiece. This is obvious as a palpable ring of tissue (Hillerton *et al*. 2000), a short-term deformation. No long-term implications of this trauma are known, but might be expected if this occurs at every milking because areas of bruising were observed for a number of cows.

The greater degree of milking-out achieved by the heavier cluster was not statistically significant and not casually obvious except for low-yielding cows. It appeared to be greater for front quarters.

Parlours fitted with the more common type of cluster and indexing performed better in the other five parameters scored, although only the effects on cow position and milking behaviour were significant ($P < 0{\cdot}05$).

A clear difference was observed in the position of cows in the parlour between those parlours with indexing and those without (Table 1; $P < 0{\cdot}05$). In indexed parlours the cows have only a little latitude in their standing position and so are always in the correct place relative to the installed milking equipment, both laterally and front to back. This allowed ergonomic efficiency in cluster attachment. Indexing ensured that there was the correct number of cows in each batch. It was common to observe more cows than milking clusters loaded in each batch in the non-indexed parlours. Where this occurred it led to significant stretching of the cluster to the cow and, when there was more than one milker, to several occasions where a cow in the middle of the batch could not be milked until an adjacent cow was finished (Fig. 1*a*). This severely affected parlour throughput. The best cluster position was in the auto tandem parlours, milking in front of the hind legs and fitted with cluster support arms.

Despite this, the effect of cluster type and indexing on cluster position just failed to reach statistical significance. Cow position and cluster position during milking were not significantly correlated. Again this may be due to confounding from the different layout of parlours with indexing and the more common type of cluster. In the parallel parlours there was obvious pull of the cluster through the hind legs (Fig. 1*b*). This was partly operator-caused as all three of these parlours were fitted with

Table 1. *Effects of cluster type and indexing on milking behaviour and performance variables. Mean scores shown, higher values indicate less satisfactory results*

Scoring range was 0 = could not be better to 3 = could not be worse

	Common cluster +index	Heavier cluster +no index	SED	P
Entry to parlour	1·00	1·29	0·56	NS
Cow position	0·22	1·43	0·49	< 0·05
Cluster position	1·00	1·43	0·26	NS
Liner slip	0·67	0·43	0·37	NS
Milking behaviour	0·33	1·43	0·37	< 0·05
Post milking behaviour	0·89	1·29	0·43	NS
Milk out (high yielders)	0·78	0·43	0·56	NS
Milk out (low yielders)	0·44	0·00	0·28	NS
Exit from parlour	0·44	0·71	0·37	NS

Correlation between cow position and cluster hang = 0·344 (NS).
NS, not significant.

long milk tube support clamps to allow correct positioning of the cluster (Fig. 1*c*). The milkers rarely used these. The ACR systems were also problematic in these three herds as the vertical pull on the cluster often resulted in bending and continued attachment to the hind teats for up to 1 min after milking (Fig. 1*d*).

A significant difference between the two parlour types was observed in the behaviour of the cows during milking (Table 1; $P < 0{\cdot}05$). The heavier-cluster parlours had significantly more dunging, urination, cow shuffling and kicking at clusters during milking. This is taken as an indication of discomfort. This occurred through the period of cluster attachment but was highly noticeable at and after the end of milk flow. The more common type of clusters were all removed by ACR while none of the heavier clusters were removed by ACR. On one of these farms there was a smooth operator routine and prompt removal at the end of milking. The effect of poor cluster removal on cow comfort in the parallel parlours with the more common type of cluster was also noticeable. It is highly probable that the main contribution to cow discomfort comes from over-milking and teat trauma. This would be supported by the observations on teat condition (Hillerton *et al*. 2000) with ringing at the base of the teat and often significant discoloration of the teat barrel.

The differences in cluster removal may be responsible for the lack of any significant difference in cows' behaviour post-milking. Immediately after cluster removal a close examination of teats was carried out. This was extremely difficult in most of the herds milked with the heavier cluster and those with poor cluster removal, the parallel parlours, as the cows were very restless.

Cows generally entered and exited from common cluster parlours better, although the difference was not statistically significant. This may have been confounded as the indexed parlours were of three different types. There were two auto-tandem parlours, in which no loading or unloading problems were ever observed. By contrast, three of the parlours had the cow stand at 90° to the pit (parallel parlours). There were obvious problems in all three in loading the last one or two cows in each batch. Larger cows found it difficult to swivel around an end post, by 90°, in less than their body length. Obvious signs of this were rubbing on the end post of the parlour stanchion and bare patches on the pelvis hook bones of several cows created as they struck the posts. A common occurrence was that the milking staff had to load these last cows manually in most batches. This is likely to have had a significant effect on parlour throughput.

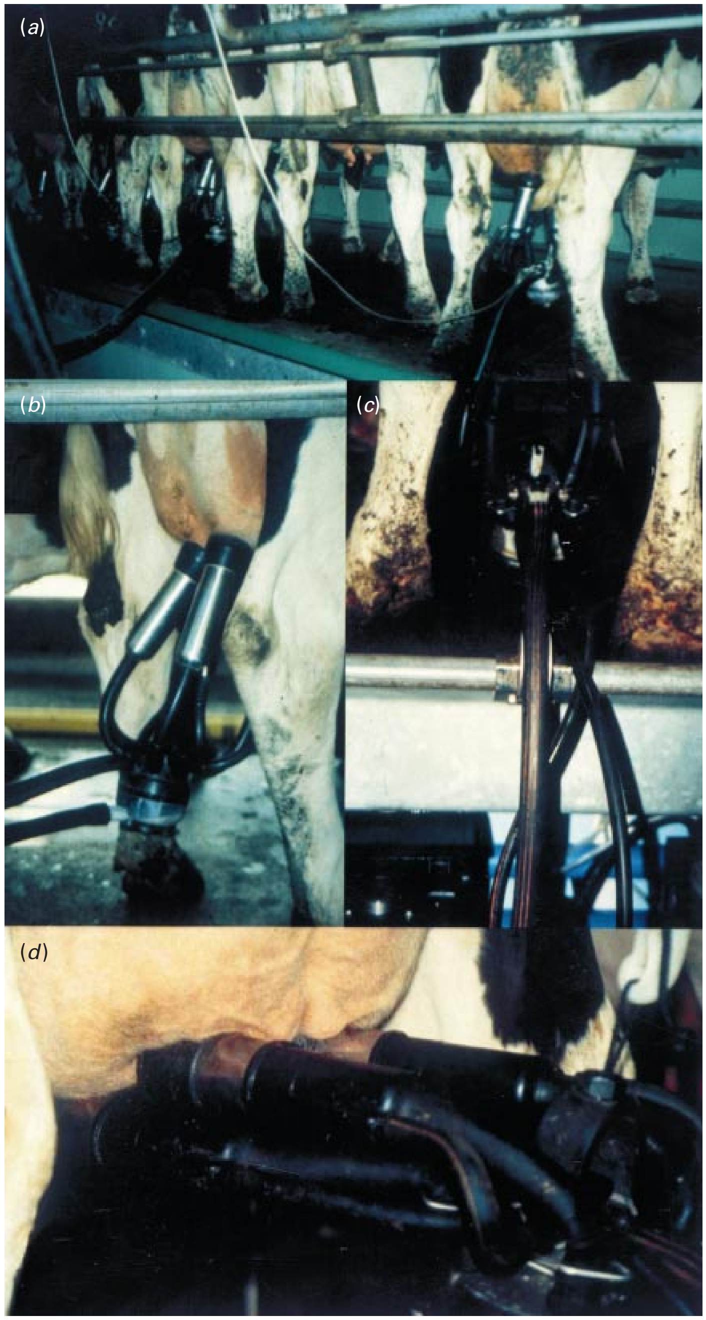

Fig. 1. (*a*) Stretching of cluster to the cow with an extra cow loaded. (*b*) Pull backwards on cluster when milking through back legs. (*c*) Correction of pull in parallel parlour by use of long milk tube support. (*d*) Poor removal of cluster in a parallel parlour.

Parlours with no indexing required the cows to stand at 80 or 90° but loading into position was much less of a problem. However, time to load did not appear significantly shorter as the cows were generally slow to walk in entry to these parlours but appeared faster on exit. The presence of an inducement significantly

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improved entry to the parlour, regardless of parlour type ($P < 0{\cdot}01$). The mean score was 0·38 for parlours with inducement and 1·87 for those without.

Indexing of standing position in the milking parlour led to a better cow position and consequently better cluster position during milking. A heavy cluster neither ensured adequate cluster position on the udder nor corrected for poor cow position. Often the problems of poor cluster position were exacerbated as excessive lengths of long milk tube were commonly used to reach the poorly positioned cow. This appeared to contribute to twist and pull on the cluster.

Cows milked with the heavier cluster system were more likely to be agitated during milking. Any over-milking may be an additional influence on cow behaviour as shown for teat condition (Hillerton *et al*. 2000). The effect was also obvious in response to handling of teats after cluster removal. Behavioural responses of the cows are a measure of stress experienced by them. The level of acceptability beyond which cow comfort deteriorates unacceptably is unknown. The cow responses of additional dunging and urinating reduce parlour cleanliness and pose a risk to the hygienic standard of milk production.

The observations and comparisons made indicate that good parlour performance and cow comfort probably start with good cow entry, require proper cow positioning, correct cluster alignment and prompt cow exit. Limiting of over-milking appears essential.

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REFERENCES

Berry, E. A. & Scrivens, M. 1997 Survey of Genus milking machine tests. *Proceedings of the British Mastitis Conference*, Genus/IAH/Novartis/MDC, p. 68

BS5545 1988 Milking machine installations. British Standards Institution, London

BS ISO 5707 1996 Milking machine installations – construction and performance. British Standards Institution, London

Hillerton, J. E., Ohnstad, I., Baines, J. R. & Leach, K. A. 2000 Changes in cow teat tissue created by milking machine action. *Journal of Dairy Research* **67** 309–317

International Dairy Federation 1997 *Guidelines for the Evaluation of the Milking Process*. Brussels: IDF (*International Dairy Federation Bulletin* no. 321), pp. 23–30

Ohnstad, I. 1997 Compliance of new milking installations with relevant standards, and static test performance. *Proceedings of the British Mastitis Conference*, Genus/IAH/Novartis/MDC, pp. 30–34

Minitab® 1995 MINITAB Release 10.51. Minitab Inc., State College, PA