

# Evaluation of the Impact of Milking Machine Design on Teat Swelling

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## Abstract

A study was completed to evaluate the effect milking machines have on teat condition of dairy cows. The study evaluated teat condition of lactating Holstein cows milked with a milking system (CoPulsation™ Milking System) consisting of low collapse force narrow bore liners and pulsation providing a C phase of less than 80 milliseconds when measured at the shell. Lactating Holstein cows were randomly selected from two herds, one herd milked in a parlor style facility and the other a pipeline facility. The exterior teat diameter of each selected cow was measured before and immediately after milking. The measurements for all teats following removal of the milking machine were smaller in diameter than the measurements made prior to machine attachment. Teat diameter data was also compared to similar prior studies in which other milking machines were shown to consistently cause an increase in teat diameter following the milking process. This study concluded that teats of cows milked with the CoPulsation™ Milking System do not become enlarged from the milking process, but rather are reduced in size. These results stand in contrast to prior studies which have concluded that cows milked with other milking systems consistently experience teat swelling as a result of the milking process.

## Introduction

Modern milking machines extract milk from the dairy cow by applying a vacuum to the teat creating a pressure difference that results in milk flowing from the teat. Vacuum is applied by placing the teat into a liner in which the interior of the liner is subjected to a vacuum. The vacuum must be periodically reduced or removed to provide the teat with a rest period. The rest period is required because the vacuum causes the fluids (blood and other fluids) to accumulate in the teat causing congestion.

Modern conventional milking machines attempt to provide this rest period by periodically applying a higher pressure (atmospheric) to the exterior of the liner causing the liner to collapse toward the teat. The typical conventional milking machine will thereby reduce the vacuum level on the teat. The periodic liner action created by the pulsing of higher pressure on the exterior of the liner is provided by a pulsator.

There have been numerous published studies documenting the effect of this milking action on the teat. A study published in the Irish Veterinary Journal (1) documents the damage inflicted on the teat by this process when cows are milked with typical modern milking machines. This study evaluates the changes in the teat structure after being milked with both conventional wide and narrow bore liners and the associated typical US style conventional pulsation and

the Irish DairyMaster style pulsation. The results are reported using a teat damage index defined as total teat sinus injury (TSI).

The study discovered that both large bore and narrow bore milking systems induced teat damage with varying scores of TSI. The study included the slaughter of some of the test animals to enable a detailed evaluation of the degradation of the teat canal lining. It was noted that varying degrees of damage was present corresponding to the TSI scoring.

Another study published in the Irish Veterinary Journal (2) documents the swelling of the teat induced by the milking process. This study utilized an ultrasound machine to complete detailed measurements of teat features including both external and internal diameters as well as teat length before and after milking. This study also compared the performance of the typical US conventional milking machine and the Irish DairyMaster style. The study discloses the fact that both styles of conventional milking machines cause teat swelling. The percentage of swelling varied with machine type and vacuum level. In all cases the external teat diameter was measurably larger (swollen) following the milking process when compared to the teat diameter prior to milking. The study also noted that the teat canal was also swollen resulting in a reduction in teat canal diameter.

The CoPulsation<sup>tm</sup> Milking System (Lisle, NY) design provides a C phase of shorter duration than conventional pulsator designs. The objective of this study was to determine if the characteristics of this pulsator provide a measurable difference in teat condition. The study consisted of randomly selecting animals from two different herds that have been milked with the CoPulsation<sup>tm</sup> Milking System for a period of time greater than one year. The diameter of the teats was measured just prior to machine attachment and again within one minute of removal of the machine.

## **Material and Methods**

This study was conducted on two dairy herds that have been milked continuously with the CoPulsation<sup>tm</sup> Milking System for more than one year. Herd A consists of approximately 40 cows milked twice a day in a high line tie stall facility with a regulated vacuum level of 16 inHg. Clusters are removed manually based on visual determination of end of milk flow. Herd B consists of approximately 100 cows milked twice a day in a low line parlor facility with a regulated vacuum level of 15 inHg. Clusters are removed automatically. Six cows were randomly selected from Herd A and 10 randomly selected from Herd B for teat size measurement. The CoPulsation<sup>tm</sup> Milking System was operated at a pulsing rate of 43 pulses per minute with a 60/40 milk to rest ratio.

External teat conditions were optically recorded just prior to teat prep for milking and immediately following machine removal. A steel rule scale was located near the teat in the same location and photographed with a digital camera at the same distance to record the before and after teat condition. This method is similar to that used in the machined parts industry known as optical comparison. An Optical Comparator is used for measuring details of small or complex machined parts. Maintaining the steel rule scale in the same position for

each measurement provides accuracy of the measurements accounting for optical depth of focus.

Photographs of before and after teat conditions were used to determine the size of the external diameter of the teat. The external diameter of the teats before and after milking were compared to determine the relative change.

## Results

The measurements of the teats milked with the CoPulsation™ Milking System showed that in all cases the external diameter of the teat had reduced. The average reduction was approximately .1 inch in diameter. An example is shown in Figure 1.



Before milking: 1.2 inches

After milking: 1.0 inches

Figure 1

This stands in contrast to the results reported by O'Callaghan in the Irish Veterinary Journal (2) in which all teats milked with conventional milking machines experienced swelling during the milking process. The O'Callaghan study (2) showed that the average teat swelling ranged from approximately .46 mm to 1.0 mm. O'Callaghan had also documented the condition of the teat in a liner in a paper (3) that shows the extreme teat swelling that occurs with a DairyMaster milking system. This swelling is consistent with the results of the increased teat diameter at the conclusion of milking with a conventional milking machine. The x-ray showing that teat swelling condition from the O'Callaghan paper is shown in Figure 2.

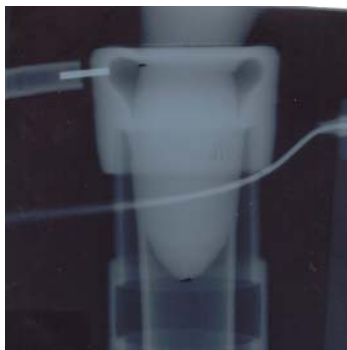


Figure 2  
x-ray of large bore liner

## **Conclusion**

The reduction of external teat diameter provided by the CoPulsation™ Milking System is unique and demonstrates that it is possible to milk a cow and not create a stressful environment that leads to teat swelling. Although this study did not measure the diameter of the teat canal, it is reasonable to assume that the cows milked with the CoPulsation™ Milking System would have teat canals that were not swollen at the conclusion of the milking process. Prior studies have demonstrated that cows milked with conventional milking systems consistently experience swelling of the teat tissue induced by the milking equipment.

## **References**

- 1 Machine Milking, Irish Veterinary Journal, Volume 56, January 2003, author: Dr Eddie O' Callaghan, Teagasc, Moorepark, Fermoy, Co Cork, Ireland
- 2 Effect of liner design, pulsator setting, and vacuum level on bovine teat tissue changes, Irish Veterinary Journal, Volume 57, May 2004
- 3 How to eliminate liner slip and improve health, Dr Eddie O' Callaghan, Teagasc, Moorepark, Fermoy, Co Cork, Ireland