Research Summaries

Dr. Craig Thatcher, *Presiding*

Bovine Mammoscopy: A New Method for Evaluating and Treating Teat Obstructions

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Partial and complete teat obstruction occurs in dairy cattle and often is caused by trauma. (1, 2) Lesions may occur in the teat canal, teat sinus, gland cistern, or in multiple sites. (3, 4) Teat obstructions proximal to the teat canal have been described as spiders and this condition is caused by proliferation of accessory glands and the formation of fibrous tissue with tumor-like masses which block the flow of milk. (5) These masses may be stationary, within the teat wall, pedunculated, or free within the teat sinus. Proliferation of tissue may involve the annular fold or the rosette of Furstenberg. Treatment of obstructions has usually been attempted blindly with the use of teat bistoury knives, alligator forceps, curettes, dilators, and other instruments inserted through the teat canal. More recently the insertion of silastic prostheses inside the teat to maintain patency of the teat sinus has been described. The results of blind teat surgery are often additional fibrosis and total teat obstruction (5) or failure to remove the lesion. Teat prosthesis require teat incisions (thelotomy) for insertion into the teat and have been noted in some cattle to come loose and migrate into the gland cistern. Treatment of teat obstructions via thelotomy has resulted in mastitis and teat fistulas. The economic loss to the dairyman from teat obstructions is substantial.

Direct visualization using rigid telescopes or flexible fiberoptic endoscopes for evaluation of lesions or for performing surgical procedures has been used in the gastrointestinal tract, the urogenital tract, the respiratory tract, the abdominal cavity, and in joints of man and animals. These viewing techniques are relatively noninvasive and surgery does not depend on large incisions for exposure of the surgical areas. The purpose of this paper is to describe the instruments and techniques needed for viewing the inside of the teat and mammary gland of cattle, using a rigid operating telescope. This procedure is termed mammoscopy. Mammoscopic surgery for the correction of teat obstructions and the effects of mammoscopy on the teat and mammary gland is also described. We believe mammoscopy will improve the ability of veterinarians to evaluate teat lesions and to successfully treat certain teat obstructions.

Instruments and Techniques for Diagnostic Mammoscopy

Mammoscopy can be performed on most cattle using a rigid operating telescope system designed for human arthroscopy. We used a 2.7mm outside diameter telescope[a] with a 25° forward viewing field (Figure 1). The telescope was used after inserting it into a 4mm trocar sleeve which was positioned in the teat sinus or gland cistern using a conical trocar. Other equipment necessary for mammoscopy included a light source and cable, a teat dilator, a modified Doyen intestinal clamp, and an intravenous administration system

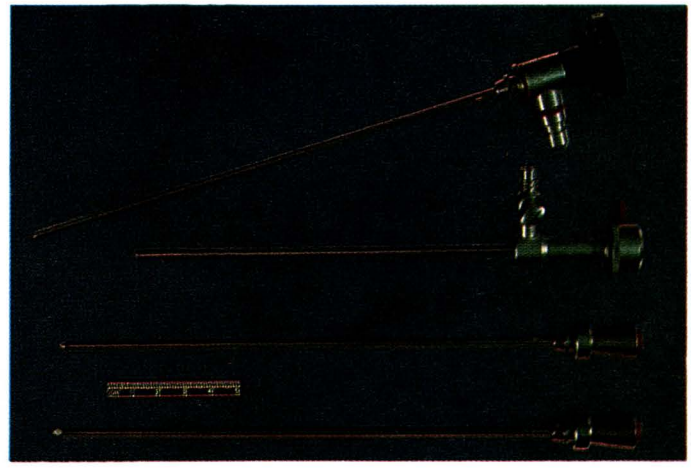

FIGURE 1. The operating telescope, trocar sleeve, and the two trocars that are used for mammoscopy.

[a]*Richard Wolf Medical Instruments Corp, Rosemont, Illinois, 60018.*

for delivery of fluids through the trocar sleeve. The Doyen clamp was modified by bending the arms of a straight Doyan into a bow and ensheathing the arms in rubber tubing (Figure 2).

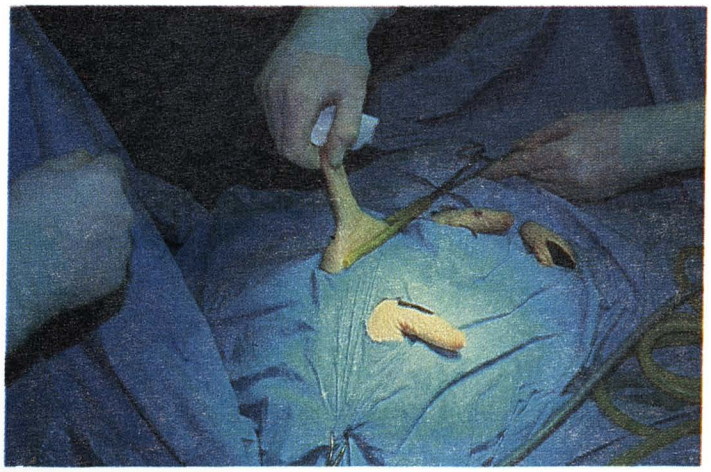

FIGURE 2. This modified Doyen intestinal clamp is used to occlude the base of the teat preventing milk from entering the teat sinus.

Prior to mammoscopy all cattle were milked and their udders washed and surgically prepared for aseptic surgery. The procedures were performed with cattle restrained in lateral recumbency or anesthetized and positioned in dorsal recumbency (Figure 3). The latter position allowed better access to the teats and easier maintenance of a sterile surgical field. For visualization only, the 4mm trocar sleeve and conical trocar were easily inserted through the teat canal. The telescope was then exchanged for the trocar to permit viewing. Occasionally the teat dilator and sterile lubricating jelly were used prior to insertion of the trocar sleeve to gently dilate small teat sphincters. Visualization required fluid distention of the teat or gland cistern. The modified Doyen intestinal clamp was placed across the base of the teat as closely as possible to the udder for viewing the teat sinus. This clamp prevented milk from entering the teat and clouding the telescopic view, and allowed teat distention with small volumes of sterile saline or Ringer's solution. Viewing of the gland cistern required larger volumes of fluid to distend the gland cistern and dilute residual milk. The modified Doyen clamp could not be used. Visualization was better with cattle in dorsal recumbency than in lateral recumbency for gland cistern mammoscopy.

FIGURE 3. Diagnostic mammoscopy being performed on an awake cow restrained in lateral recumbency.

Methods of Mammoscopic Surgery and the Effects on the Teat and Mammary Gland

Simultaneous viewing and instrument manipulation within the teat required two portals, one for the telescope and one for the instruments. The telescope and instruments should converge on the lesion. This technique is often termed triangulation by arthroscopists. A second portal of entry required a stab incision through the teat wall. The techniques for triangulation were developed using experimental cattle. These cattle were also used to determine the effects of intramammary fluid administration.

Materials and Methods. Three healthy lactating cattle were purchased and housed in stanchions at the Large Animal Clinic. They were milked twice daily. Samples for bacterial isolation were taken from all 12 quarters and were negative. A California mastitis test (CMT), the conductivity index using a Mas-D-Tec (MDT) instrument[b] and a somatic cell count (SCC) were determined on milk samples from all quarters to evaluate for mastitis on days 1, 4, 5, 6, 7, 8 and 11 of the study. The CMT reaction was scored with the number 0, 1, 2, 3, and 4 corresponding to the negative, trace, +1, +2, and +3 reactions read from the paddle. All samples were collected prior to the morning milking. Quarters were infused with 500 ml of saline (6 quarters) or 500 ml of Ringer's solution (6 quarters) on day 4 after the cows were milked and samples collected. Each cow received saline in 2 quarters and Ringer's solution in 2 quarters. The mean CMT and MDT scores and the mean SCC were determined for milk samples taken 2 days before infusion, and 2 days after infusion to determine the effect of the fluids on the mammary gland. The mean CMT and MDT scores and the mean SCC were calculated separately for saline and Ringer's solution on all samples taken after day 4 for comparison of the two infusion fluids.

All cattle were anesthetized after day 11 and positioned in dorsal recumbency. The telescope was inserted into the teat sinus by making a 4mm skin incision approximately two-thirds of the distance from the teat end to the base of the udder. The clamp was placed cross the base of the teat and the teat was distended by infusion of fluids through a teat canula. The trocar sleeve with the pyramidal trocar was pushed through the teat wall at a 45° angle from the long axis of the teat into the teat sinus and the trocar was exchanged for the telescope to permit viewing. Instruments such as a biopsy

[b] *Wescor Inc., Logan, Utah, 84321*

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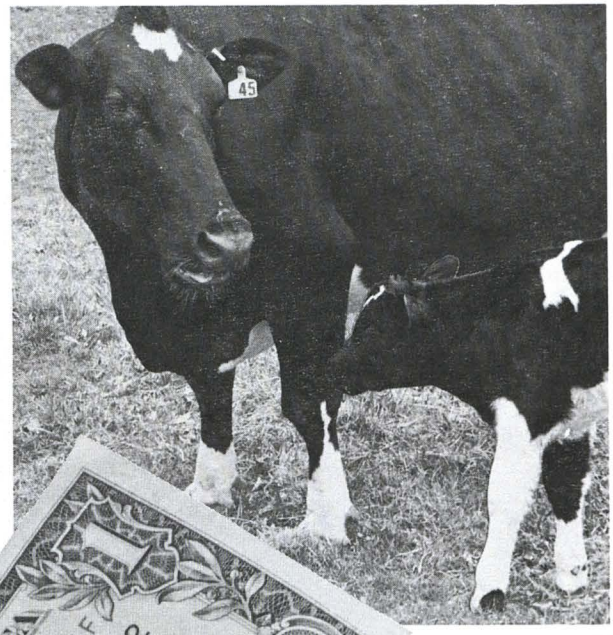

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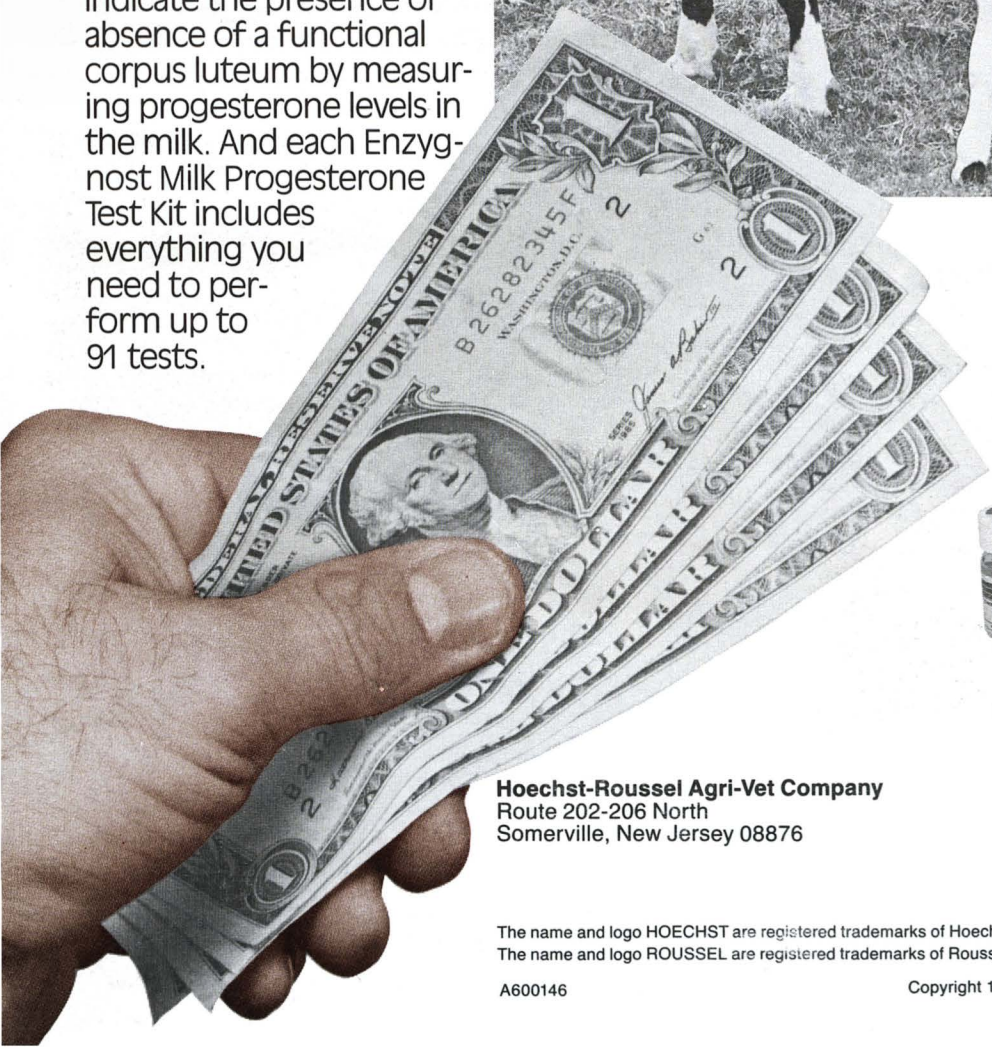

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cutting forceps designed for operative arthroscopy, with diameters of 4mm or less were inserted through the teat canal for manipulation within the teat sinus under direct visualization. After removal of the instruments and telescope the skin incisions were closed with 2 or 3 simple interrupted or interrupted vertical mattress sutures with 2-0 polypropylene material[c] on a cutting needle. The sutures were placed through the skin and connective tissue layer but did not penetrate the mucosa. Sutures were removed from 7 to 18 days after surgery. The teats were not bandaged and cattle were milked the same day of surgery and thereafter by machine only.

Results of the Experimental Study. Infusion of saline and Ringer's solution into the mammary glands caused a significant rise in the CMT and MDT scores but did not significantly alter the SCC (Table 1). By day 11 the CMT and MDT scores had returned to pre-infusion range. There was no significant difference in the CMT and MDT scores or the SCC's between quarters infused with saline and infused with Ringer's solution (Table 2).

TABLE 1. Mean Milk Score for CMT, MAS-D-TEC, and Somatic Cell Counts After Infusion With Saline and Ringers.

	Before	After
CMT	.75	1.7+
MDT	1.5	4.4++
SCC (x10^3)	1275	506

\+ Significantly different at $p<.01$
++ Significantly different at $p<.001$

TABLE 2. Saline Versus Ringers. Mean Milk Score for CMT, MAS-D-TEC and Somatic Cell Counts After Infusion.

	Saline	Ringers +
CMT	1.5	1.1
MDT	4.2	4.6
SCC (x 10^3)	393	317

\+ Scores not significantly different from saline.

Visualization of the teat sinus through the teat wall portal was excellent. All areas from the teat canal to the junction of the teat sinus and gland cistern could be examined with the clamp in place (Figures 4 and 5). With the clamp removed the gland cistern was easily viewed. A well defined annular fold was not noted in any of the quarters. This is compatible with other studies which indicate the annular fold is often absent. (6) Operating instruments could easily be inserted through the teat canal and manipulated within the entire teat sinus while being viewed by the operator through the telescope (Figure 6).

Following mammoscopy one quarter bled each time the cow was milked for 5 days. A vein had been perforated during insertion of the telescope through the teat wall in this cow. More careful observation by the operator may have avoided this error. Six teats developed suppurative reactions in the wall around the skin sutures. These reactions occurred in

FIGURE 4. Furstenburg's rosette is visualized via the telescope placed through the teat wall. Notice the keratin plug in the teat canal has been disrupted by inserting of an instrument through the teat canal.

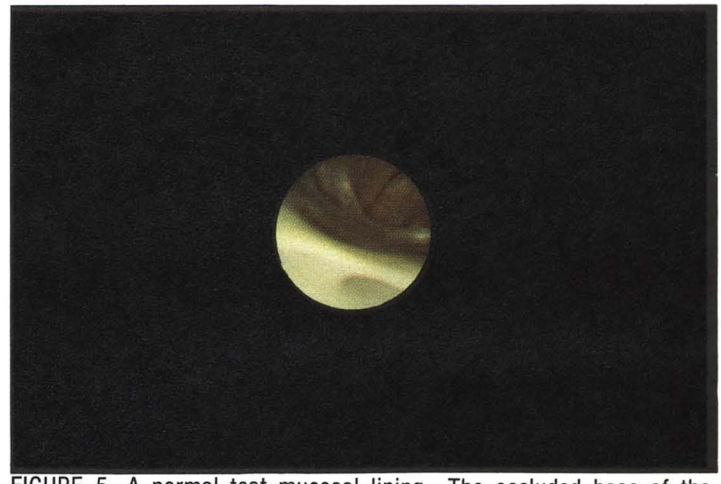

FIGURE 5. A normal teat mucosal lining. The occluded base of the teat can be seen in the background.

FIGURE 6. This biopsy cutting forceps has been inserted through the teat canal into the teat cistern and can be used to grasp masses within the teat.

[c]*Ethicon, Somerville, New Jersey, 08576-0151*

teats where sutures were left in place longer than 10 days. The suppurative reactions may have been caused by the constant irritation from the milking machine, and because the teats were not bandaged and were exposed to environmental contamination. The simple interrupted suture pattern seemed to cause less reaction than the vertical mattress pattern. No teats developed milk fistulas.

Discussion

The equipment adapted for use in mammoscopy proved to be satisfactory for viewing the inside of the teat and mammary gland. Mammoscopic surgery may require multiple entries of the surgical instruments into the teat. For this reason we elected to place the viewing telescope through the teat wall so the instruments could enter and exit the teat sinus through the teat canal. Once positioned the telescope does not have to be removed thereby limiting trauma to the teat wall. Many teat obstructions involve the teat canal. (3) The rosette of Furstenburg and the teat canal can be viewed easily with a teat wall telescope portal.

Mammoscopy appears safe for the cow. Severe reactions to the infusion fluids were not noted. Saline appears to be reasonably safe for infusion into the udder and is less expensive than Ringer's solution. Saline has not gained popularity for arthroscopic surgery because it is mildly irritating to joints. Lesions confined to the teat may be visualized with distention by small volumes of fluid providing the teat clamp is used. In these instances the fluid can be massaged out of the teat and does not enter the gland. Mammoscopy utilizing distention of the teat with gas is a possible alternative to fluids but has not been tried by us. Teat fistulas caused by teat wall telescope portals should not present a major problem.

We believe diagnostic mammoscopy will allow veterinarians to more accurately evaluate teat lesions, to better select methods of therapy, and to provide a more accurate prognosis to the dairyman. Most of our experience to date on clinical patients has been with diagnostic mammoscopy. Several cattle presented to our clinic for teat obstructions have been noted on mammoscopy to have occlusion of the teat sinus and gland cistern thereby making standard surgery or prosthesis insertion unsuitable. Mammoscopic surgery for teat obstructions where direct visualization of lesions occurs should aid in the removal of lesions with minimal damage to the surrounding teat mucosa and teat canal. This should decrease the incidence of postoperative fibrosis and reobstruction and increase the success of teat surgery. We need to accumulate more case material using mammoscopic surgery and compare a mammoscopic surgery to standard teat surgery to confirm this hypothesis.

Mammoscopy may prove useful as a research tool for evaluating various intramammary products for following the progress of mastitis and mastitis treatment, and for determining the pathogenesis of teat obstructions.

Limitations of mammoscopy include the expense of the equipment and the time necessary to gain experience using it. Many cattle will not warrant mammoscopy due to low economic value. Facilities for adequate restraint during mammoscopy are necessary.

Time and additional experience with the techniques of mammoscopy will better define the value for teat surgery and investigational purposes.

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