

Milk flow and udder health in cows after treatment of covered teat injuries via theloressectoscopy: 52 cases (2000–2002)

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Objective—To determine milk flow, somatic cell counts (SCCs), and the incidence of clinical mastitis in cows that had undergone theloressectoscopy for treatment of teat stenosis caused by mucosal detachment in the region of the streak canal or Fürstenberg's rosette.

Design—Retrospective study.

Animals—52 cows with teat stenosis that were treated via theloressectoscopy.

Procedure—Medical records of eligible cows were reviewed. Additional data regarding milking ease, SCC, development of clinical mastitis of the affected gland, and whether the cow remained in the herd were collected via owner-completed questionnaires.

Results—49 of 52 questionnaires were completed. At referral, teat sinusitis was diagnosed in 29 of 52 cows. Milk flow was normal in 38 of 41 treated teats at discharge and in 24 of 40 during the next lactation. Thirteen of 49 cows were culled during the next lactation because of abnormal udder health. High SCC and teat sinusitis at referral and development of clinical mastitis during the 10-day period after surgery resulted in high SCCs in the remainder of the current lactation. The incidence of clinical mastitis during the remainder of the current and during the next lactation was higher in cows that had teat sinusitis at the time of surgery, compared with those that did not.

Conclusions and Clinical Relevance—Teat stenoses resulting from mucosal lesions in the region of the streak canal or Fürstenberg's rosette may be successfully treated via theloressectoscopy. Inflammation of the teat sinus and gland at the time of surgery may adversely affect udder health. (*J Am Vet Med Assoc* 2005;226:1119–1123)

In addition to mastitis and lameness, obstructing teat injuries are common reasons for culling dairy cows.^{1,2} Seventy to 90% of teat injuries are covered injuries that do not involve the teat skin.^{3,a} These injuries are caused by contusions of the tip of the teat or the distal teat wall. In 80% to 90% of such injuries, teat stenosis is caused by mucosal detachment in the region of the streak canal or Fürstenberg's rosette (folds situated at the internal end of the streak canal).^{4,b} The free end of the detached tissue projects into the papillary sinus and obstructs the streak canal in a valve-like fashion during milking.^c

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During the past 20 years, the use of sonography and endoscopy has led to considerable advancements in the diagnosis and treatment of teat stenoses caused by mucosal detachment. These imaging modalities provide accurate information about the size and location of stenotic mucosal lesions. In the past, covered teat injuries were treated conservatively by not milking the affected gland and draining the milk passively every 3 days to allow the acute inflammation to subside or treated surgically via blind resection of obstructing tissue through the streak canal. These methods resulted in unsatisfactory udder health and milk flow.^{3,5,a,c} Treatment of covered teat injuries via thelotomy yields better results with regard to milk flow; however, it is time-consuming and does not improve udder health.^{5,c} To avoid these disadvantages and minimize teat trauma caused by thelotomy, 2 endoscopic techniques were developed. In 1 method, conventional endoscopy is used to identify obstructive tissue, which is then removed with a cutter.^{6,7} The other method involves theloressectoscopy, a procedure that uses a rigid endoscope and a surgical high-frequency snare combined in 1 instrument. Theloressectoscopy can be performed by 1 person, and the development of tissue hyperplasia and strictures composed of scar tissue after surgery with the high-frequency loop is reportedly decreased, compared with conventional endoscopy involving a cutter.^{8,9} Both methods allow introduction of an endoscope through the streak canal or through an opening created in the teat wall to view lesions in the area of the streak canal or Fürstenberg's rosette.⁸

Short- and long-term studies^{7,10-12} have been performed to investigate the productivity of cows after classical teat endoscopy for the surgical treatment of covered teat lesions. However, to our knowledge, the productivity and udder health of cows after theloressectoscopy have been investigated only in short-term studies^{8,13,14} involving small numbers of cows. The purpose of the study reported here was to determine the flow and somatic cell count (SCC) of milk and the incidence of clinical mastitis in cows that had undergone theloressectoscopy for treatment of teat stenosis caused by mucosal detachment in the region of the streak canal or Fürstenberg's rosette.

Criteria for Selection of Cases

Seventy-two cows underwent theloressectoscopy at the Clinic of Reproductive Medicine, University of Zurich, between September 2000 and June 2002. They were eligible for inclusion in the study if records indicated that there was no visible lesion on the skin of the

teat from which milk flow was impaired, the stenosis of the streak canal was caused by detached mucous membrane of the Fürstenberg's rosette or streak canal, and there were no other causes of abnormal milk flow. Fifty-two cows from 52 different farms met these criteria. Only 1 teat was affected in each cow. The owners of the cows were sent a questionnaire 15 to 36 months after surgery; 49 of 52 (94.2%) questionnaires were completed and returned.

Procedures

The medical records of eligible cows were reviewed. At the time of admission of each cow, the history was obtained and the udder was examined. A California mastitis test (CMT) and microbial culture of a milk sample from the gland with the injured teat were carried out. The result of the CMT was scored as negative (equivalent SCC, 0 to 500,000 cells/mL), 1+ (equivalent SCC, 400,000 to 1,500,000 cells/mL), 2+ (equivalent SCC, 800,000 to 5,000,000 cells/mL), or 3+ (equivalent SCC, > 5,000,000 cells/mL), depending on the amount of precipitation and gel formation detected.¹⁵

Milk samples were cultured by use of standard methods.¹⁶ Agar plates^d were used to culture *Staphylococcus* spp, which were identified on the basis of production of DNase; in addition, blood agar^e (trypticase-soy agar with 5% sheep blood) was used to assess hemolysis. *Staphylococcus* spp with $\beta\delta$ - or δ -hemolysis and positive results of the DNase test (deemed positive if diameter of the reaction zone was ≥ 2 mm) were classified as *Staphylococcus aureus*; all other species were classified as other *Staphylococcus* spp. The CAMP test and brain-heart-infusion-esculin bouillon^{f,g} were used to further differentiate *Streptococcus* spp. Those with positive results of the CAMP test and negative results of the esculin test were identified as *Streptococcus agalactiae*, those with negative results of the CAMP test and negative results of the esculin test were identified as *Streptococcus dysgalactiae*, and those with negative or positive results of the CAMP test and positive results of the esculin test were identified as *Streptococcus uberis*. Gram-negative rod bacteria were confirmed biochemically as *Escherichia coli* (on the basis of acid production from mannitol, results of an ortho-nitrophenyl-D-galactopyranosidase test for β -galactosidase, detection of hydrogen sulfide and indol production, and confirmation of the presence of urease and lysine decarboxylase). Fungi and *Corynebacterium bovis* were identified on the basis of their slow colony growth, colony morphology, and characteristic gram-negative staining.

Treatment and follow-up—All cows were sedated with xylazine hydrochloride^h (0.05 mg/kg [0.023 mg/lb], IV), and oxytocinⁱ (20 units, IV) was administered. A teat cannula was inserted into the injured teat to empty the gland. The cow was placed in lateral recumbency with the affected teat uppermost. After aseptic preparation of the teat skin, 20 mL of a 2% lidocaine solution^j was injected circumferentially around the base of the teat. A rubber tourniquet was placed around the base of the teat to prevent milk flow and

reduce the amount of bleeding in the surgical field. The papillary sinus was rinsed with physiologic saline (0.9% NaCl) solution. A conical trocar situated within a cannula (length, 10.5 cm; diameter, 3.7 \times 4.7 mm) was introduced through the streak canal into the teat lumen and used to perforate the teat wall at the transition of the middle and upper third portion of the teat. The cannula was advanced into the opening in the teat wall, and the trocar was withdrawn. A theloresectoscope^k was then introduced through the cannula into the teat sinus. The theloresectoscope consisted of a 19.7-cm-long rigid endoscope with a straight forward 0° telescope and a coagulation electrode attached to it. The endoscope had a diameter of 1.9 mm in the region of the lens. The endoscope with an attached loop electrode was enclosed in a shaft (outer diameter, 3.63 mm) through which air could be insufflated. The shaft had a handgrip that controlled longitudinal movement of the electrode. After insufflation of the teat sinus, the obstructing tissue was identified and removed via electrocoagulation. The theloresectoscope and cannula were withdrawn, and the perforation in the teat wall was closed by use of 3-0 nylon suture^l in a cruciate suture pattern. The tourniquet was removed, and milk flow was assessed by milking by hand. The gland was infused with a broad-spectrum antimicrobial drug containing penicillin and neomycin.^m A wax bougieⁿ was inserted into the streak canal,^o and the teat was bandaged. All cows underwent a clinical examination once daily for the following 9 days. The milk in the affected gland was drained through a teat cannula on days 3, 6, and 9 after surgery. The skin sutures were removed on day 10, and machine milking was resumed. All cows were discharged after 3 additional milkings.

In October 2003, a questionnaire concerning ease of milking of the treated teat and SCC in the milk from that gland, development of clinical mastitis in the affected gland, and whether the cow remained in the herd (including reasons for culling, if applicable) was sent to all owners. As well, the results of CMTs performed at the beginning of the cow's next lactation and SCCs of composite samples of milk in the month before surgery; at 1, 3, and 6 months after surgery; and in the first month of the next lactation were requested.

Statistical analyses—The data were analyzed by means of computer software.^o The mean values and SE were calculated, and *t* tests, multivariate ANOVA with post hoc tests (Fisher protected least significant difference test), χ^2 tests, and univariate together with multivariate logistic regression analysis were carried out. Values of *P* \leq 0.05 were considered significant.

Results

Among the 52 cows eligible for inclusion in the study, 29 were Swiss Braunviehs, 15 were Simmentals, and 8 were Holstein Friesians. Of all cows, 45 of 52 (86.5%) originated from farms with tie stalls. The mean herd size was 20 milking cows (range, 5 to 60 cows), and mean production was 7,313.8 \pm 1,102.5 L (range, 4,800 to 9,900 L) of milk/305 days. For 2 cows, the lactation period during which the teat injury occurred was not known. Of the 50 cows for which data were avail-

able, 13 (26%) cows received their teat injury during their first lactation, 11 (22%) were injured during their second lactation, 15 (30%) were injured during their third lactation, 7 (14%) were injured during their fourth lactation, 3 (6%) were injured during the fifth lactation, and 1 (2%) was injured during its sixth lactation.

Hind teats were affected in 40 of 52 (76.9%) cows. The right front teat was affected in 5 (9.6%) cows, the left front teat was affected in 7 (13.5%) cows, and the right hind teat was affected in 16 (30.8%) cows. The left hind teat was most frequently affected (24/52 [46.2%] cows; $P < 0.001$). The mean interval between the teat injury and admission to our clinic was 17.2 days (range, 1 to 56 days). During that interval, 37 of 52 (71.2%) affected teats were treated by a referring veterinarian; the treatments included temporary suspension of milking the affected gland ($n = 16$) and infusion of antimicrobial into the affected gland (18). In some instances, surgical removal of obstructing tissue by use of a teat knife introduced through the streak canal (without endoscopy) was attempted (20). After the resection procedure, sinusitis characterized by erythema and swelling and proliferation of the mucosa was diagnosed via endoscopy in 11 of those 20 (55%) teats, which was significantly ($P < 0.05$) higher than the proportion of teats that developed sinusitis among those not treated or treated via medical management.

Of the samples of milk collected from each of the 52 injured teats, 8 appeared grossly abnormal and 15 yielded positive results on microbial culture. Compared with a milk sample that yielded negative results on microbial culture, a milk sample from an affected gland that yielded positive results on microbial culture was more likely ($P < 0.05$) to be grossly abnormal and yield positive results via a CMT at the time of admission. At the time of admission, the result of the CMT was unknown in 1 cow. Of the 51 cows for which data were available, results of the CMT performed on milk collected from the injured teat of each cow at admission were negative in 12 (23.5%) cows, 1+ in 4 (7.8%) cows, 2+ in 12 (23.5%) cows, and 3+ in 23 (45.1%) cows. Compared with cows in which milk from the injured teat yielded a CMT result that was negative or 1+, cows with a CMT result of 2+ or 3+ at the time of admission were more likely ($P < 0.05$) to have clinical mastitis in the gland with the injured teat and high CMT scores for samples of milk from that teat during the remainder of their current lactation. Microbial culture of milk samples from the 52 affected glands revealed pure cultures in 13 samples and 2 microbial agents in 2 samples. Microbes cultured included *S aureus* ($n = 4$), *Staphylococcus* spp (3), *S uberis* (3), *Streptococcus* spp

(3), yeast (2), *E coli* (1), and *C bovis* (1). Cows with positive results on microbial culture of milk collected from the injured teat at the time of admission were 4.95 times as likely to be culled by the end of their next lactation than cows with negative results on microbial culture of milk collected from the injured teat at the time of admission ($P < 0.05$; odds ratio, 4.95; 95% confidence interval, 1.23 to 20.00). Of 20 cows that were culled, 13 (65%) were removed because of mastitis.

At the time of admission, teat sinusitis was diagnosed in 29 of 52 (55.8%) cows. These cows had significantly ($P < 0.05$) higher SCCs ($396,000 \pm 127,000$ cells/mL) 6 months after theloressectomy, compared with cows with no teat sinusitis at the time of admission ($130,000 \pm 117,000$ cells/mL). In addition, in the remainder of their current and the next lactations, cows with teat sinusitis at the time of theloressectomy had a mean of 1.6 episodes of clinical mastitis in the gland with the injured teat, compared with 0.2 episodes of clinical mastitis in the gland of the injured teat in cows with no teat sinusitis ($P < 0.01$).

Cows that had clinical mastitis of the affected gland during the 10-day period after surgery had a significantly ($P < 0.01$) higher SCC in composite milk samples during the remainder of their current lactation than cows that did not develop mastitis (Figure 1). Machine milking of the affected gland was evaluated on day 10 after surgery, before discharge from the clinic. In 3 of 52 (5.8%) cows, machine milking revealed that the affected gland emptied more slowly than the contralateral gland. Compared with values in composite milk samples collected from cows that had normal milk flow rates from affected glands at machine milking on day 10 after theloressectomy, the SCCs in milk samples collected from these 3 cows were significantly ($P < 0.05$) higher at 3 months

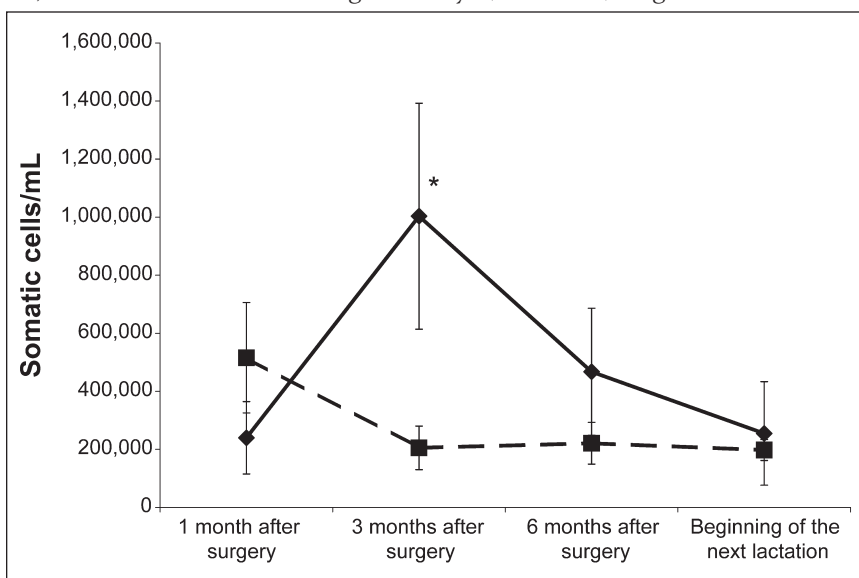


Figure 1—Mean \pm SD somatic cell counts in composite milk samples obtained from cows with covered teat injuries (1/cow) that underwent theloressectomy and did ($n = 4$; diamonds) or did not (13; squares) develop clinical mastitis in the affected gland during the 10-day period following surgery. *Value significantly ($P < 0.01$) different from the value in cows that did not develop mastitis postoperatively.

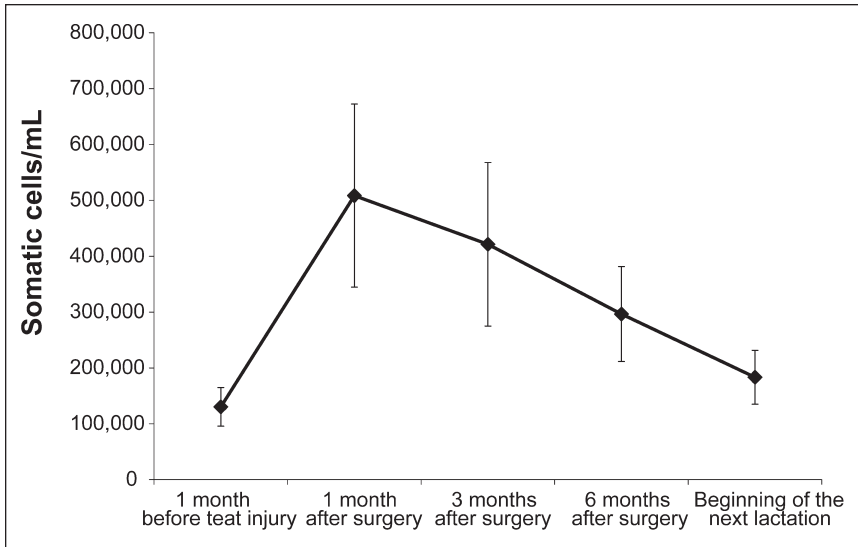


Figure 2—Mean \pm SD somatic cell counts in composite milk samples obtained during the current lactation (before teat injury and after treatment) and at the beginning of their next lactation from cows ($n = 15$) with covered teat injuries (1/cow) that underwent theloressectomy.

(1,014,667 \pm 561,232 cells/mL vs 236,333 \pm 76,697 cells/mL) and 6 months (672,000 \pm 258,906 cells/mL vs 186,133 \pm 541,350 cells/mL) after treatment.

There were significant differences among the SCC values obtained for composite samples of milk during the cows' current lactations and at the start of their next lactations. The mean SCC was highest (508,400 \pm 163,848 cells/mL) in the first month after treatment ($P < 0.05$; Figure 2).

In affected glands, as many as 3 episodes of clinical mastitis developed during the remainder of the cows' current and next lactations. The incidence of clinical mastitis during the study period was associated with the SCC before the teat injury; during the month before the teat injury, cows that did not develop mastitis in the gland affected by injury had a mean SCC of 75,917 \pm 24,036 cells/mL, compared with a value of 282,500 \pm 217,500 cells/mL in cows with 3 episodes of mastitis in the gland affected by injury ($P < 0.05$).

By the end of the lactation that followed the cows' current lactation at the time of admission to the clinic, 20 of 49 (40.8%) cows for which owners completed a questionnaire were culled. Thirteen of the 20 (65%) cows were culled because of mastitis. Cows culled because of mastitis had a mean of 1.8 episodes of clinical mastitis of the affected gland, compared with 0.1 episodes in cows culled for other reasons ($P < 0.05$). At discharge from the clinic, milk flow was considered good in 38 of 41 (92.7%) treated teats. At the start of the cows' next lactation, milk flow in the treated teats was comparable to that of the other teats in 24 of 40 (60.0%) cows that were still used in dairy production.

Discussion

The advantages of endoscopy for surgical repair of distal mucosal lesions of the teat have been described in detail. Endoscopy is a minimally invasive surgical technique that allows direct viewing of the obstructing tissue, which can be removed via a high-frequency surgical cutting technique.^{9,10,17,b} With the introduction

of endoscopy, older methods such as thelotomy have become less popular because they are highly invasive and generally have a poor outcome.^{3,5,a,c} Theoscopic triangulation⁷ and lateral endoscopy are 2 methods that were developed to incorporate endoscopy in the treatment of teat stenosis; in the latter, a cutter is introduced via the streak canal to remove the obstructive tissue.⁶ Theloressectomy also can be performed via the streak canal or, alternatively, through an opening in the lateral teat wall. Because the endoscope and high-frequency snare are incorporated in 1 instrument, an additional instrument portal in the teat wall is not required, thereby eliminating the need for an assistant. It is conceivable that because of its minimal invasive-

ness, theloressectomy should result in a better long-term outcome regarding milk flow from treated teats than other currently used techniques.

In the present study, 60.0% of the cows that were still in production had normal milk flow at the start of the next lactation. This result is similar to that of a short-term evaluation of theloressectomy in which 59.4% of treated teats had normal milk flow 6 weeks after surgery⁸ and that of a long-term assessment of theoscopic triangulation in which 75.9% of treated teats had normal milk flow.¹⁰ Zulauf and Steiner¹⁴ reported that 14 of 15 (93.3%) teats treated by theloressectomy had normal milk flow in short- and long-term evaluations.

A favorable long-term outcome for a treated teat depends not only on resumption of normal milk flow but also on other aspects of udder health; in the cows in the present study, the latter were affected mainly by the condition and treatment of the udder before theloressectomy. Teats that had undergone blind resection of obstructing tissue before referral had an increased incidence of acute to chronic proliferative teat sinusitis. Subsequently, this was associated with an increased incidence of clinical mastitis in the affected gland and increased SCC in composite milk samples collected 6 months after theloressectomy. In addition, detection of positive results via CMT and microbial cultures of milk samples from affected glands at the time of admission had a negative effect on the outcome of surgery. Earlier studies^{7,c} have revealed that the time interval between teat injury and referral as well as the type of teat treatment instituted by the referring veterinarian affect the outcome of surgery. Moreover, the long-term outcome of teat surgery is impacted not only by inappropriate treatment of a teat prior to referral but also by the development of clinical mastitis during the period after surgery when the gland is drained only every 3 days. It is therefore imperative that the affected gland, while temporarily not being milked, is assessed daily for signs of inflammation and that extreme care is taken during passive draining of milk.

In the cows of the present study, the mean SCC of composite milk samples was increased after theloressectoscopy but reached acceptable levels by the start of the cows' next lactation. Thus, teat surgery may not be indicated for cows that are planned to be culled after completion of their current lactation. The mean SCC at the start of the next lactation after treatment ($183,757 \pm 40,099$ cells/mL) was only slightly higher than the value determined before teat injury ($120,815 \pm 25,192$ cells/mL). In agreement with the results of other studies,^{18,19} the highest SCC in our study was detected in the first month after theloressectoscopy. As well, findings of our study confirmed the beneficial effect of a complete dry period after theloressectoscopy on the SCC that has been reported by others.^{10,14}

Of 49 cows that underwent theloressectoscopy and for which follow-up questionnaires were returned by owners, 20 (40.8%) were culled before the end of the next lactation. Of these, 13 cows were culled because of unsatisfactory milk flow from the treated teat, recurrent clinical mastitis of the affected gland, or poor milk production. Culling rates reported after endoscopic teat surgery in other similar studies were 64%¹⁹ and 18%.¹⁰

Theloressectoscopy is a useful method for treatment of mucosal lesions in the region of the streak canal and Fürstenberg's rosette. However, a high SCC and clinical mastitis, most likely related to impaired defense function afforded by the compromised streak canal, are potential limiting factors for a favorable long-term outcome of this procedure; inappropriate treatment of the teat before referral for theloressectoscopy appears to predispose the gland to these disorders. Attempts at blind resection of obstructing tissue and the use of teat dilators or plastic indwelling catheters may result in teat sinusitis.¹³ These types of treatments combined with impaired streak canal function result in a higher incidence of clinical mastitis. In cows that have had such treatments, the usefulness of theloressectoscopy is questionable because of a poor prognosis. Thus, glands with impaired milk flow as a result of acute teat stenosis should temporarily undergo a reduced milking routine and be drained passively with a teat cannula every 3 days to allow acute inflammation to subside. Surgical repair should be instituted when a definitive diagnosis has been established. With these measures, satisfactory udder health can be expected in the remainder of the current and subsequent lactations of cows that undergo theloressectoscopy.

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