Invasive Teat Surgery in Dairy Cattle I. Surgical Procedures and Classification of Lesions

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Abstract

A prospective study was performed to identify the nature and management of teat abnormalities in cows presented to a referral teaching hospital during a three year period. All cattle (n = 60) admitted to the Ontario Veterinary College for teat problems were evaluated by physical examination; in 53 teats, contrast radiography or xeroradiography were obtained. Surgery was performed on 52 teats from 51 cows and a prosthesis was implanted in 27 teats. Short term (under two weeks) complications included intraoperative bleeding (n = 6), milk leakage through the incision (n = 4), and failure to milk by machine in 26 cases. Histopathological diagnosis of sections taken from obstructive lesions included fibrous tissue (n = 8), normal mammary tissue (n = 3), fibropapilloma, mammary polyps, and inflamed mucosa (one each). The lesion could be classified into five types: 1) focal teat cistern obstruction, 2) diffuse teat cistern obstruction, 3) membranous obstruction, 4) diffuse teat and gland cistern obstruction, or 5) leakage of milk through an abnormal route (i.e. teat fistula, webbed teat, or lacerations).

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Résumé

Chirurgie profonde du trayon, chez la vache laitière I. Techniques chirurgicales et classification des lésions

Les auteurs ont réalisé une étude prospective visant à déterminer la nature des anormalités des trayons, ainsi que la façon de les traiter, chez 60 vaches hospitalisées au Collège Vétérinaire de l'Ontario, au cours d'une période de trois ans. Elles subirent toutes un examen physique qui, pour 53 trayons, incluait la radiographie de contraste ou la xéromammographie. Les auteurs effectuèrent une intervention chirurgicale sur 52 trayons de 51 vaches et ils introduisirent une prothèse dans 27 de ces trayons. Les complications suivantes apparurent en moins de deux semaines: six cas de saignement, au site de l'intervention chirurgicale; quatre cas d'écoulement de lait, par l'incision chirurgicale; 26 cas où l'utilisation de la trayeuse mécanique s'avéra inefficace. L'histopathologie des lésions obstructives révéla huit cas de prolifération de tissu fibreux; trois cas de tissu mammaire normal; un fibropapillome; un polype mammaire et une inflammation de la muqueuse. La classification des lésions en donna les cinq types suivants: 1) obstruction focale de la citerne du trayon; 2) obstruction diffuse de la citerne du trayon; 3) obstruction membraneuse; 4) obstruction diffuse de la citerne du trayon et de la glande mammaire correspondante; 5) écoulement de lait par un orifice anormal tel que fistule, lacération ou trayon membraneux.

Introduction

Teat abnormalities in dairy cattle are believed to be common, but little information is present to document the prevalence of the problem (1-2). Most of the published research papers have focused on the teat canal and sphincter and their roles as anatomical, physical, and physiological barriers against infection (3-8). Little is reported regarding abnormalities of teat and gland cisterns that lead to impaired milk outflow.

Thirty years ago, it was reported that teat obstructions carried a poor prognosis following treatment; only 13 out of 43 teats treated returned to normal function (2). There have been many reports of successful surgical treatments of teat abnormalities, but these papers did not offer long-term follow-up information (1, 2, 9-15). Success in most papers was apparently defined as return to milk flow immediately after surgery. In one author's report, of 43 cases of teat obstruction, a 30% success rate was described following various treatments (2). Another author reported a 92% success rate when performing a thelotomy in 38 cows with prolapsed mucous membrane of the proximal teat canal (14). Recently, Donawick described a different surgical technique and introduced a teat prosthesis which consisted of silastic tubing that helped to prevent excessive postoperative fibroplasia (15).

The purpose of this prospective study of teat abnormalities was to describe diagnostic and surgical techniques, and to report intraoperative and early in-hospital complications. A classification of teat abnormalities correlated with treatment regimes and prognoses will also be presented. In

part two of this study, long-term complications and follow-up will be described (16).

Materials and Methods

All cattle (n = 60) presented to the Large Animal Clinic of the Ontario Veterinary College (OVC) between September 1983 and June 1986 with abnormalities of the mammary gland or teat resulting in a decrease or absence of milk outflow were included in this prospective study. The following information was recorded: age, quarter involved, the duration of the problem, and the historical cause of problem. At the time of admission, a routine physical examination was performed. The age distribution of the population in this study was compared to that of the general hospital population during that period using the Chi-square test.

The teat and gland cistern were palpated for any obstruction to milk flow or anatomic abnormalities. A blunt teat cannula was passed through the teat canal to assess patency and abnormalities of the mucosa of the teat and gland cistern.

If the teat cistern was at least partially patent, contrast radiography or xeroradiography was performed. This was done by aseptic preparation of the involved teat, followed by injection of 10 mL of an iodine-based radiopaque material (Renografin-76, E.R. Squibb & Sons, Inc. Princeton, New Jersey) through the teat canal into the gland and teat cistern. A lateral radiograph or xeroradiograph was obtained (Figure 1). Radiographic examination was performed in 53 of 61 teats. In 46 of the 53 cases radiographed, a thelotomy was performed to attempt correction of the obstruction. The radiographs were re-evaluated at the completion of the study and the classification based on the radiographic findings was compared to that based on surgical findings.

Treatments were not randomized but left to the discretion of the attending surgeon. Once surgical treatment was elected, a specific protocol was followed in all cases.

Preoperative Management

The animals were fasted for 12 to 24 hours preoperatively in order to reduce ruminal distension during the surgical procedure. Preoperative intramammary antibiotics were administered if the teat or gland cistern was still patent, and systemic antibiotics (procaine penicillin G, 10,000 IU/kg, intramuscularly) in all cases.

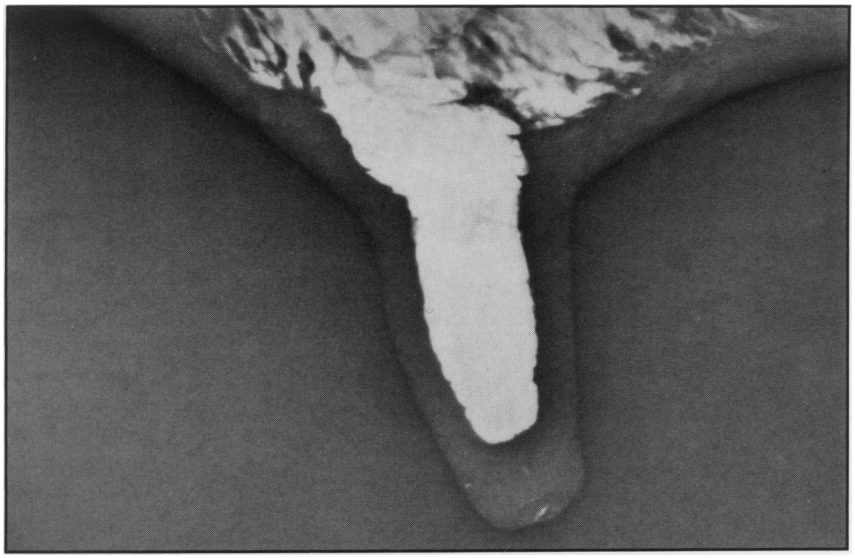

Figure 1. Lateral xeroradiograph of a front teat of a normal cow.

The cow was sedated with xylazine hydrochloride at a dose of 0.05 mg/kg intravenously (Rompum, Haver-Lockhart, Miles Laboratories, Rexdale, Ontario) and then positioned in lateral or dorsal recumbency. Additional intraoperative doses of xylazine hydrochloride (0.04-0.05 mg/kg) were administered intravenously as needed. Local anesthesia was obtained using infiltration of lidocaine hydrochloride (without epinephrine) at the base of the teat in the form of a ring block.

Operative Protocol

The surgical treatment elected in each cow is summarized in Table I. Decisions were based on recommendations made by Donawick (15).

a) Thelotomy without prosthesis (n = 25) — Following aseptic preparation and draping of the surgical site, a vertical incision was made on the side of the teat opposite to the lesion. The incision never entered the teat canal or the rosette of Furstenberg. Sharp incisions were used throughout all layers, and incised vessels were ligated with 3-0 polyglactin 910 (Vicryl, Ethicon Sutures Ltd., Peterborough, Ontario). Correction of the teat obstruction was accomplished in 22 (42%) of the cases by excising the abnormal tissue. The resulting defect was covered by mobilizing adjacent mucosa, sliding it over the defect, and suturing it in place (Figure 2A, 2B).

The mucosa was closed using a simple continuous pattern with 4-0 polyglactin 910. Closure of the stroma (connective tissue and muscles) was obtained with a simple interrupted or continuous pattern with 3-0 polyglactin 910. Skin closure was completed with

TABLE I
Summary of Treatment Elected for Mammary Obstructions in 52 Teats Operated Upon at the Ontario Veterinary College between September 1983 and June 1986

Type of Lesion	n	Thelotomy n (%)	Thelotomy with Implants n (%)
I	13	7 (46)	6 (54)
II	4	0 (0)	4 (100)
III	13	5[a] (30)	8 (70)
IV	10	1[b] (10)	9 (90)
V	12	12 (100)	0 (0)

In 4[a] and 1[b] of these animals, no milk was found at surgery, so treatment was considered hopeless and implants were not placed in the teats.

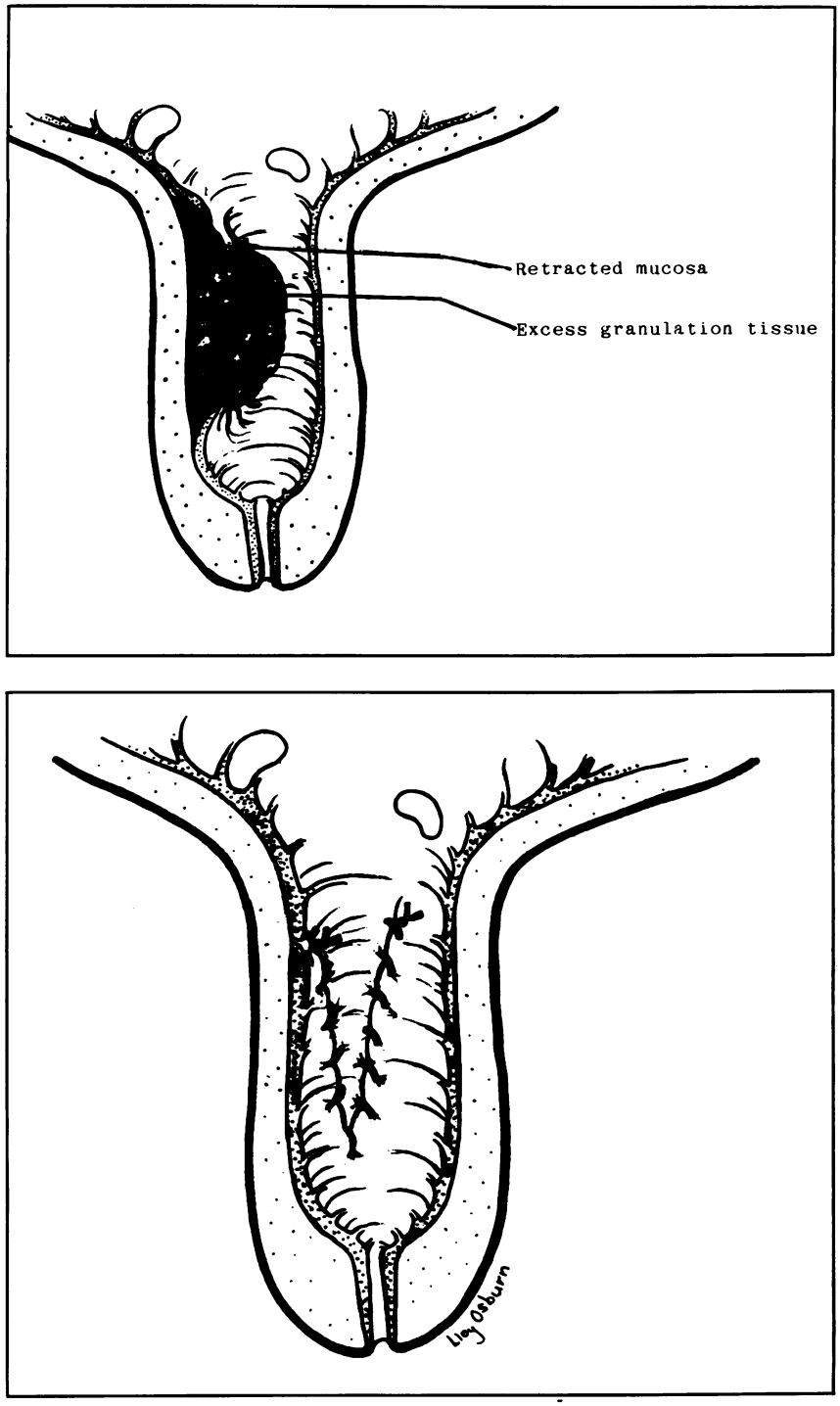

Figure 2. A: Area devoid of mucosa. B: A section of mucosa has been slid over and sutured in place to cover the defect.

a simple interrupted pattern using 3-0 polypropylene (Prolene, Ethicon Sutures Ltd., Peterborough, Ontario).

b) Thelotomy with prosthesis (n = 27) — In 27 of 52 (52%) teats, the mucosal defect could not be covered adequately. Consequently, a teat prosthesis was placed in the teat cistern. The implant consisted of sterile silastic tubing (7 mm ID, 10 mm OD, Silastic silicone medical tubing, American Scientific, McGraw Park, Illinois). It was placed so that it rested on the distal extremity of the teat cistern (Figure 3A). The tubing extended proximally over the mucosal defect until approximately 1 cm of normal mucosa was covered as previously recommended (15). The prosthesis was secured in place with a noncapillary, nonabsorbable, monofilament 2-0 polypropylene suture material. Two to three sutures were placed equidistant through the prosthesis into the stromal tissue of the teat (Figure 3B). If the implant extended into the gland cistern, then the proximal part of the implant was fenestrated.

Postoperative Management

Milking of the quarter by machine was attempted immediately postoperatively. Animals were generally discharged within three days of surgery. Intramammary and systemic antibiotic therapy were discontinued after three days unless longer treatment was required (i.e. for bacterial mastitis). The skin sutures were removed 10 to 14 days postoperatively.

Results

The age distribution of the 60 cows with teat problems admitted to the OVC differed from the age of all the cattle admitted to the hospital during the same period of time (Chi-square = 32.07, df = 3, $p<0.001$) (Figure 4). There were 61 teat problems encountered in 56 Holstein-Friesian and four Jersey cows. One Jersey heifer had both front quarters affected. The left and right front quarters were involved with equal frequency (n = 19; 31%) while the left and right hind quarters were affected in 14 (23%) and nine (15%) cases respectively. The duration of problems prior to referral ranged from one day to three years, but 75% (n = 45) of the cows were affected for less than one month. The historical causes of the teat abnormalities included: physical injury (n = 14; 23%) and severe mastitis (n = 5; 8%). In 42 (69%) cases, the cause was unknown.

Surgical treatment was attempted in 52 (85%) of the 61 teats. Surgical treatment was not performed in nine cases because of a poor prognosis felt to be associated with extensive teat and gland cistern fibrosis in six cases, the presence of severe mastitis in two cases, or the presence of a teat sphincter laceration which did not require surgical treatment in one case. All but one cow were operated upon during the lactation period.

Based on the surgical findings in 52 teats, the anomalies were retrospectively classified into five categories: Type I — focal teat cistern obstructions involving less than 30% of the mucosal surface of the teat cistern (n = 13) (Figure 5); Type II — diffuse teat cistern obstructions

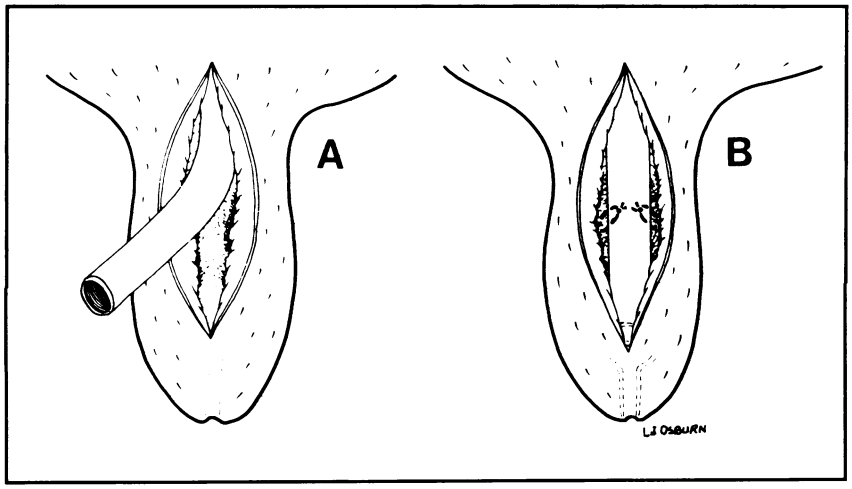

Figure 3. A: Silastic prosthesis being inserted in a teat cistern to rest against its distal extremity. B: Silastic prosthesis is secured in place with two or three sutures of a nonabsorbable monofilament suture material.

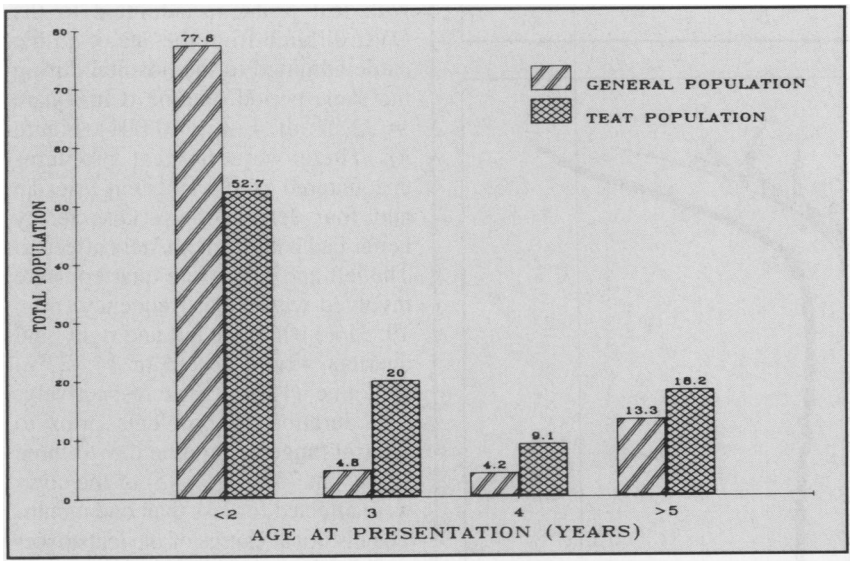

Figure 4. Age distribution of cows admitted with teat problems versus general hospital population.

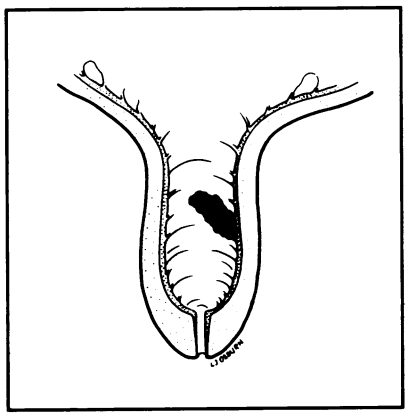

Figure 5. Type I: Obstruction where a mass of granulation tissue or stenosis was present but affected less than 30% of the mucosal surface of the teat cistern. The mucosa proximal or distal to the lesion is grossly normal.

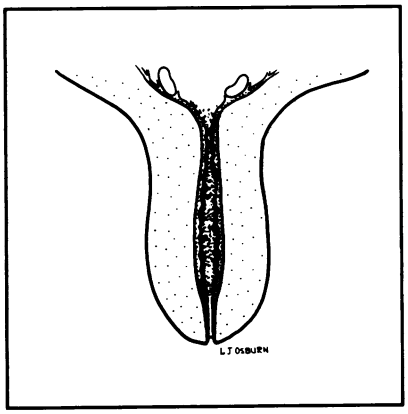

Figure 6. Type II: Obstruction where greater than 30% of the teat cistern mucosa was abnormal due to stenosis or proliferating granulation tissue. Mucosa proximal to the lesion was grossly normal. Teat canal is normal in appearance.

involving greater than 30% of teat cistern mucosa (n = 4) (Figure 6); Type III — a membranous or fibrous structure separating either the gland cistern from the teat cistern, or the lactiferous ducts from the gland cistern (n = 13) (Figure 7); Type IV — stenosis or obliteration of the gland and the teat cisterns (n = 10) (Figure 8); and Type V — teat fistulae, webbed teats, or lacerations leading to fistulae (n = 12) (Figure 9).

The radiographic interpretations were found to be accurate when compared to the surgical findings in 29 of the 46 cases (63%) (Table II).

The same principles of treatment were observed by all of the surgeons involved in this study. Focal obstructions of the teat cistern (Type I) were treated by excision of the granulating tissue masses as others have recommended (12-15, 16). If this resulted in a small amount of mucosal loss, adjacent mucosa was undermined and slid over the defect. On the other hand, if the removal of the obstruction resulted in extensive mucosal loss, prosthetic implant was employed as previously described (10, 12, 16). Types II, III, and IV lesions generally required prosthetic implants. Type III lesions differed from Type IV lesions in that, in Type III lesions, relatively normal-sized gland cisterns containing varying quantities of milk were present. If during the surgery no significant quantity of milk could be obtained in the gland cistern, treatment was considered hopeless.

Teat fistulae (Type V) were repaired by direct revision and reapposition of separate anatomical soft tissue planes. It should be noted that in all instances when physical injury was not the cause of the fistula, a separate gland cistern was present and emptied through the fistula. Occasionally a small complete teat was present giving the appearance of a webbed teat (Figure 10). This was rare and in general only the fistula and some excess tissue were found (Figure 9). These two abnormalities have been previously reported but resection of the teat and associated mammary gland has been suggested (17). In our study, the mammary gland feeding the fistula was often of similar size to the normal gland. Thus it was considered inappropriate to resect these structures. Instead a window was created between the proximal part of the common wall of the normal teat and

the fistula. The edge of this window was sutured to appose mucosal wall of the normal teat and fistula. This procedure led to emptying of both mammary glands into the normal teat.

Excessive intraoperative bleeding, due to surgical trauma to the venous plexus, complicated surgery in six (11%) cases. In all cases, the vessels were found and ligated. In one case, a second thelotomy was needed two days postoperatively to remove a blood clot from the gland cistern. A significant quantity of milk (greater than 20 mL) was not found at surgery in five cows. These animals never produced milk from the affected quarter after surgery. Incisional leakage of milk immediately postoperatively was observed in four (8%) cases. In two of the four cases, the cows were immediately replaced into dorsal recumbency and, following aseptic preparation, a revision of the closure was performed. In the two other cases, leakage ceased after the first milking. In the immediate postoperative period, 12 (23%) of the 52 lactating cows did not milk from the operated quarter, 14 (27%) had to be milked with a teat cannula or Foley catheter, and 26 (50%) were milked using a wide bore teat cup. If the cow could not be milked in the first 24 hours, a teat cannula was inserted through the teat canal under sterile conditions, and the teat and gland cisterns were flushed with sterile saline. If there was no physical obstruction, the quarter was drained with the teat cannula until it could be milked by machine. In one case, it was felt that a physical obstruction prevented milk outflow. Surgical revision was done through an incision opposite to the first thelotomy. In this one case, excessive mucosal swelling was found and therefore a prosthesis was placed in the teat cistern.

Histopathological sections were obtained in 14 (27%) of the 52 operated teats. Granulation tissue was identified in eight cases, normal mammary tissue in three cases, and one of each of the following in the other three teats: fibropapilloma, mammary polyps and inflamed tissue.

Discussion

Although the case information was collected prospectively, treatments were not randomly allocated and the resulting classification used was determined retrospectively, so caution must be used in interpretation of the data.

The age distribution of the cows with teat problems differed from the general hospital population. The reason for this is probably related to the fact that teat obstructions and fistulae are not diagnosed until the animals are lactating. Therefore animals were not referred until they were at least two years of age.

The apparently higher prevalence rate of disorders affecting the front quarter (n = 38) versus the hind quarters (n = 23) is difficult to explain. Perhaps front quarters are more susceptible to physical injury by the cow. This apparent prevalence for front

TABLE II
Comparison of the Accuracy of Radiographic Examination Alone versus Classification Based on Surgical Findings (n = 46)

Type of Teat Anomaly Based on Surgery (n)	Teats Radiographed n = (%)	Correctly Identified n = (%)[a]
I (13)	13 (100)	11 (85)
II (4)	4 (100)	3 (75)
III (13)	12 (92)	3 (25)
IV (10)	10 (100)	4 (40)
V (12)	8 (67)	8 (100)

[a] Overall accuracy rate 63%

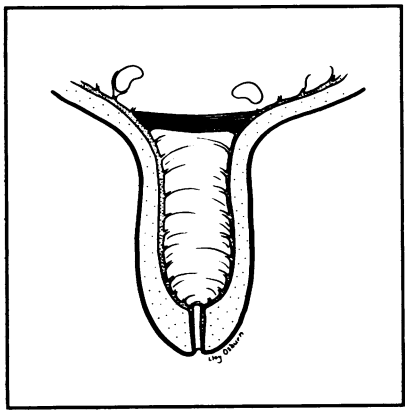

Figure 7. Type III: Obstruction due to presence of a membranous or fibrous structure between gland and teat cistern or between lactiferous duct and gland cistern. The mucosa of the teat cistern is normal.

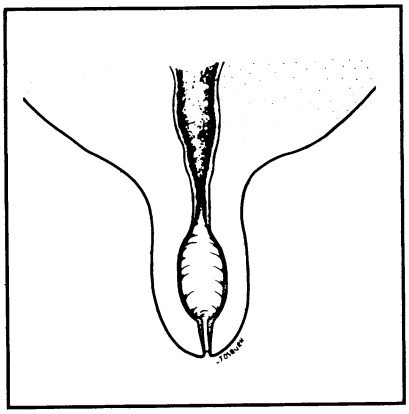

Figure 8. Type IV: Obstruction due to fibrosis and stenosis of an extensive portion of the teat and gland cisterns (>30%). The mucosa is abnormal in the constricted area.

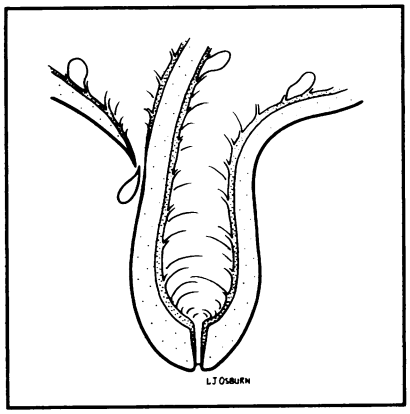

Figure 9. Type V: Abnormalities where a teat fistula, a webbed teat, or a laceration leading to a fistula was present. The mucosa of the teat or gland cistern is inflamed or normal.

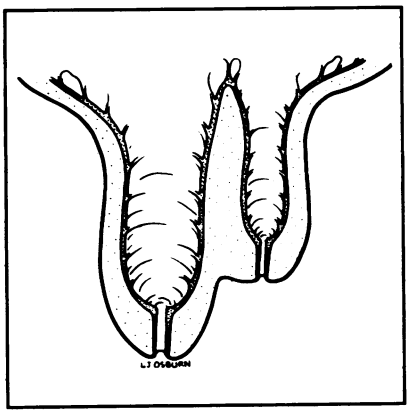

Figure 10. Webbed teat where the teat and gland cisterns of the adjacent glands share a common wall but their lumens do not communicate.

quarter problems is different from previously reported data where the reverse prevalence was described (18).

The duration of the teat problems, represented by the time period from the recognition of the problem by the owner to the presentation at the OVC, ranged from one day to three years. The problem could have been present for longer periods of time, but was only discovered when lactation began.

A history suggestive of an acquired teat anomaly was identified in 23% (n = 14) of the cases. This may suggest that a large proportion of teat anomalies are indeed congenital entities. However, surgical impression was that, in the majority of cases, fibrous tissue was the cause of the obstructions. This suggested that unobserved physical injury may have more frequently been the cause. When one considers the management of heifers prior to calving, wherein little observation of the mammary gland is made, it is reasonable to assume that unobserved injuries to the teats may occur. It has also been reported that physical injury to the teat may result from chronic mastitis, traumatic hand milking, calves sucking each other, and tick bites (17).

Radiographic evaluation did not correlate as well with surgical findings as may have been expected from a previous report (13). However, it should be pointed out that in this study only one view (lateral) was used, and we did not use double contrasts as has been previously recommended (13).

The type of injury seen in this study is similar to that reported by other surgeons (1, 2, 9-15), except for the limited number of lacerations and teat canal problems in our group. Indeed, most of the latter problems are treated by practitioners and not referred to our hospital.

In summary, there are different types of teat problems and they require different interventions. The surgical procedure with or without implantation of a prosthesis is simple, but care is needed to identify and treat postoperative complications early. The short-term success, defined as milk production at the time of discharge is good (77%). The classification suggested is based on the abnormalities documented at surgery rather than solely on palpation, and therefore may be more accurate than others (1, 2, 14).

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