

Parenteral Treatment of *Streptococcus agalactiae* Mastitis in Kenyan Camels (*Camelus dromedarius*)

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Key words

Camelus dromedarius – *Streptococcus agalactiae* – Mastitis – Therapy – Kenya.

Summary

Intramammary *Streptococcus agalactiae* infections in nine camels (*Camelus dromedarius*) were treated by a three-day course of intramuscular injection with three different antibiotics to assess whether this route of application had any effect on the quarter infection status. A benzylpenicillin procain dihydrostreptomycin-base combination (12 million IU/12 g per day), penethamate hydroiodide (10 million IU per day) and erythromycin (10 mg/kg per day) were used on three groups of three camels, respectively. Penicillin-streptomycin eliminated *S. agalactiae* from three out of four infected quarters, penethamate hydroiodide had a curative effect on two out of four quarters, while erythromycin did not alter the infection status of any of the three *S. agalactiae*-infected quarters treated.

INTRODUCTION

In the absence of control measures *Streptococcus agalactiae* is the most common mastitis pathogen in dairy cattle (2) with average morbidity rates of 25% (15). *S. agalactiae* eradication programs have been successful in dairy cattle herds and are economically justified (4, 7, 15). Intramammary infections (IMI) with *S. agalactiae* (Lancefield type B) in camels are common and have been diagnosed in the United Arab Emirates (14), Egypt (8), Sudan (1, 11) and Somalia (19).

In North Kenya, *S. agalactiae* IMI prevalences of up to 50% in market-orientated camel dairy herds (20) have become a concern to camel owners. One case of successful parenteral treatment of mastitis in a camel is reported in the literature (3). Published treatment recommendations for mastitis in camels have not been validated (6, 21).

A limited number of intramammary *S. agalactiae* infections in lactating camels were treated with intramuscularly administered antibiotics to assess whether the drugs and dose rates used showed potential for parenteral treatment of *S. agalactiae* mastitis in camels. The findings are presented in this paper.

MATERIALS AND METHODS

Treatments of naturally occurring *S. agalactiae* IMI were carried out in two commercial camel herds producing milk for marketing

and in one ranch camel herd in the Laikipia and Isiolo districts of North Kenya. Lactating quarters chosen for treatment attempts showed no signs of clinical mastitis and no visible or palpable pathological changes. The persistence of previously identified *S. agalactiae* IMI was reconfirmed from samples taken on day one of the treatment. Animals were allocated to groups of three for the different treatment protocols tested.

The intramuscular injection was chosen as the route for administration of antibiotics to camels with *S. agalactiae* IMI considering the following points:

- Camel herdsmen in North Kenya were familiar with the administration of injectable drugs, while the use of intramammary tubes for treatment of mastitis was new to them;
- Due to the smaller diameter of camel teats, intramammary tubes designed for administration in cattle are often unsuitable for routine use in camels. Camel teats have two or three teat orifices. There is disagreement as to whether the different teat openings also represent separate gland complexes (9, 18);
- Intramuscular-injection administration was cheaper and treated the whole udder while intramammary treatment was costly and treated only one quarter of the gland.

Injections were administered by the investigator. Body weights of lactating females varied between 550 and 660 kg as calculated from body measurements (5). All drug vials were kept in a cool box to account for the heat and light sensitivity of penicillin (10). Animals were resampled 11 days after the end of treatment and again, if possible, 1 to 1.5 month posttreatment to assess the bacteriological cure rate.

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The choice of antibiotic drugs was based on: (i) previous information on antibiotic sensitivity patterns of *S. agalactiae* from camel mastitis in Kenya (20) and on *S. agalactiae* from bovine mastitis (7, 15); (ii) increasing use of penicillin-streptomycin for camel treatments in North Kenya (penethamate hydroiodide was included because it is available in powder form, which may be of advantage under hot conditions); and (iii) established knowledge on the ability of macrolide antibiotics to cross the blood-milk barrier in the bovine udder and recommendations for their use (15).

The first group of three camels with *S. agalactiae* IMI was treated with an injectable benzylpenicillin procain dihydrostreptomycin-base combination (Intramicine®, CEVA). A dose of 12 million IU benzylpenicillin procain (plus 12 g dihydrostreptomycin) per day given in two separate injections of 6 million IU (plus 6 g dihydrostreptomycin), morning and evening, was administered intramuscularly for three consecutive days.

The second group of three camels received penethamate hydroiodide (Ingel-Mamyzin® 10 Mega, Boehringer Ingelheim, Germany). This penicillin is provided in powder form and has to be reconstituted for application. All together, 10 million IU were injected intramuscularly every 24 h on three consecutive days (one vial or 15 ml of the reconstituted product per day).

The third group was treated with an injectable erythromycin (Erythrocin 200®, CEVA) given intramuscularly at a dose rate of 10 mg/kg (= 5 ml per 100 kg; dosage according to recommendations by Dr P. Tessier of CEVA) once daily for three consecutive days.

Milk samples were collected before and after treatment. Each teat was disinfected and sampled separately. The first streams of milk were discarded and 10 ml of milk were squirted into sterile rubber-cap tubes. The samples were transported in a portable fridge under constant refrigeration and reached the laboratory within 48-72 h.

The milk was cultured on blood agar (Oxoid CM 271, 5% defibrinated sheep blood), on Edwards agar (Oxoid CM 27, 5% defibrinated sheep blood) and in Todd Hewitt broth (Oxoid CM 189), and incubated at 37°C overnight. The Todd Hewitt broth enrichment cultures were subcultured onto blood agar and Edwards agar after overnight incubation. Catalase-negative Gram-positive cocci showing blue colony appearance and no esculin hydrolysis on Edwards agar that tested positive for the presence of Lancefield group B antigen (Oxoid DR 587 latex grouping reagent B, DR 593, DR 592) were classified as *S. agalactiae*. Environmental mastitis pathogens were not included in the analysis.

Agar diffusion sensitivity tests on *S. agalactiae* isolated from the nine camels before and after treatment were performed on Mueller Hinton agar (Oxoid CM 337) with 5% defibrinated sheep blood according to a standard test procedure (17). Oxoid sensitivity discs containing 5 µg erythromycin and 1.5 µg penicillin were used.

California mastitis test (CMT) fluid containing 37.5 g Marlon PS 60 and 0.1g bromocresol purple per liter was used. The results were read on a white plastic paddle according to the manufacturer's instructions.

■ RESULTS

All mastitis cases treated were in a non-acute stage having been diagnosed for the first time 1-3.5 months before treatment. The three antibiotics used were well tolerated by the animals.

Treatment results are summarized in Tables I to III. Penicillin-streptomycin eliminated *S. agalactiae* IMI from three out of four infected quarters. Penethamate hydroiodide had a curative effect on two out of four quarters with *S. agalactiae* IMI. Erythromycin

Table I

Response of intramammary infection by *Streptococcus agalactiae* in camels to parenteral penicillin-streptomycin¹ treatment

Camel		Pretreatment		1 st day of treatment		11 days posttreatment	
Num.	Teat	S.a. type B (IMI) (observed duration)	CMT	S.a. type B (IMI) IMI status	CMT	S.a. type B (IMI) IMI status	CMT
33	FL	Non infected	-	Non infected	-	Non infected	-
	HL	Non infected	-	Non infected	-	Non infected	-
	FR	Infected (1 month)	+	Infected	+	Infected	+
	HR	Non infected	-	Non infected	-	Non infected	-
40	FL	Non infected	-	Infected	+	Non infected	- ²
	HL	Non infected	-	Non infected	-	Non infected	- ²
	FR	Infected (1 month)	-	Infected	++	Non infected	- ²
	HR	Non infected	-	Non infected	-	Non infected	- ²
88	FL	Infected (2 months)	+	Infected	+	Non infected	- ³
	HL	Non infected	-	Non infected	-	Non infected	-
	FR	Non infected	-	Non infected	-	Non infected	-
	HR	Non infected	-	Non infected	-	Non infected	-

¹ Six million IU benzylpenicillin procain plus 6 g dihydrostreptomycin i.m., 6x at 12 h interval

² Absence of *Streptococcus* type B IMI from all four quarters was confirmed 1.5 month posttreatment

³ No longer lactating 1.5 month posttreatment

S.a.: *Streptococcus agalactiae*, IMI: intramammary infection, CMT: California mastitis test

FL: front left quarter, HL: hind left quarter, FR: front right quarter, HR: hind right quarter

did not alter the infection status of the three *S. agalactiae*-infected quarters treated. There was no difference in sensitivity to penicillin G and erythromycin of *S. agalactiae* isolated from the nine mammary glands before and after treatments.

Observation of the herdsmen's reactions to the different treatment protocols clearly indicated that a three-day course of twice-daily injections (benzylpenicillin procain dihydrostreptomycin) would not be accepted or applied in the absence of the investigator.

Table II
Response of intramammary infection by *Streptococcus agalactiae* in camels to parenteral penethamate hydroiodide¹ treatment

Camel		Pretreatment		1 st day of treatment		11 days posttreatment	
Num.	Teat	S.a. type B (IMI) (observed duration)	CMT	S.a. type B (IMI) IMI status	CMT	S.a. type B (IMI) IMI status	CMT
92	FL	Infected (3.5 months)	+	Infected	+	Non infected	- ²
	HL	Non infected	-	Non infected	-	Non infected	- ²
	FR	Dead quarter (no sample)		Dead quarter		Dead quarter	
	HR	Non infected	-	Non infected	-	Non infected	- ²
774	FL	Not sampled		Non infected	-	Non infected	-
	HL	Non infected	+	Non infected	-	Infected	- ³
	FR	Not sampled		Non infected	-	Non infected	-
	HR	Infected (2 months)	+	Infected	+	Infected	+
P2	FL	Infected (2 months)	+	Infected	+	Infected	+
	HL	Non infected	+	Non infected	+	Non infected	-
	FR	Infected (2 months)	+	Infected	+	Non infected	-
	HR	Non infected	+	Non infected	+	Non infected	+

¹ Penethamate hydroiodide 10 million IU i.m., 3x at 24 h intervals

² Absence of *Streptococcus* type B IMI from lactating quarters was confirmed one month posttreatment

³ This was most probably a posttreatment infection

S.a.: *Streptococcus agalactiae*, IMI: intramammary infection, CMT: California mastitis test
FL: front left quarter, HL: hind left quarter, FR: front right quarter, HR: hind right quarter

Table III
Response of intramammary infection by *Streptococcus agalactiae* in camels to parenteral erythromycin¹ treatment

Camel		Pretreatment		1 st day of treatment		11 days posttreatment	
Num.	Teat	S.a. type B (IMI) (observed duration)	CMT	S.a. type B (IMI) IMI status	CMT	S.a. type B (IMI) IMI status	CMT
7	FL	Infected (2 months)	+	Infected	+	Infected	+
	HL	Non infected	-	Non infected	-	Non infected	-
	FR	Non infected	-	Non infected	-	Non infected	-
	HR	Non infected	-	Non infected	-	Non infected	-
P5	FL	Non infected	-	Non infected	-	Non infected	+
	HL	Non infected	+	Non infected	+	Non infected	-
	FR	Infected (2 months)	+	Infected	+	Infected	+
	HR	Non infected	-	Non infected	-	Non infected	-
85	FL	Infected (2 months)	-	Infected	+	Infected	+
	HL	Non infected	-	Non infected	-	Non infected	-
	FR	Non infected	-	Non infected	-	Non infected	-
	HR	Non infected	-	Non infected	-	Non infected	-

¹ Erythromycin 10 mg/kg i.m., 3x at 24 h interval

S.a.: *Streptococcus agalactiae*, IMI: intramammary infection, CMT: California mastitis test
FL: front left quarter, HL: hind left quarter, FR: front right quarter, HR: hind right quarter

The three-day course of once-daily injections (erythromycin, penethamate hydroiodide) was better accepted.

Animals P2 and P5 were of Pakistani breed. Both had oversized teats that were too large for the calf to suckle. They appeared to be prone to frequent infections by varying environmental mastitis pathogens and constantly showed irritations of the udder as reflected in CMT results.

■ DISCUSSION

Intramammary application of antibiotics in extensive husbandry systems is risky and may do more harm than good (12). Parenteral mastitis treatment is more effective in acutely inflamed quarters due to the increased permeability of the blood-milk barrier (16). The main factor responsible for the outcome of *S. agalactiae* mastitis treatments is the drug concentration established and maintained for 72 h in the milk (15).

The parenteral application of penicillin for *S. agalactiae* mastitis treatment in dairy cattle offers the advantage of ease of application and simultaneous treatment of all four quarters, but high doses (> 5 million IU) are needed and the cure rate in chronic infections is low (2, 7). Duration of intramammary *S. agalactiae* infection before treatment has a major impact on the success of any treatment attempt (7). Intramammary treatment of *S. agalactiae* in dairy cows during lactation produces cure rates of 87.5% for early stages of infection and 14.7% for late stages of infection (7). Bacteriological cure rates for acute streptococcal mastitis in cattle in response to parenteral treatment are recorded to be 65% (13). Since it was not possible to establish the onset of infections in the lactating camels treated, the influence of different durations of intramammary infection on the treatment success remained obscure. Pastoralists will usually only consider treatment of acute mastitis in camels. In such acute mastitis cases parenteral application of penicillin can be expected to result in higher cure rates than the ones recorded in this paper. Resistance of *S. agalactiae* to the antibiotics used can be ruled out as a cause of treatment failure in this trial.

■ CONCLUSION

The results indicated that a three-day course of benzylpenicillin procain dihydrostreptomycin or penethamate hydroiodide at the dose rates recommended for parenteral mastitis treatment in cattle holds promise for parenteral treatment of *S. agalactiae* mastitis in camels. It could potentially be applied for treatment of acute mastitis, as a prophylaxis when subdividing infected camel herds into clean and unclean subgroups, when introducing camels of uncertain udder infection status into non-infected herds and to complement intramammary treatments. Furthermore, detailed trials should be carried out before recommending such treatment strategy. Penicillin formulations for use in camels should also be tested with regards to their stability under hot conditions and intensive sunlight.

From this very limited field trial it could not be concluded whether the observed differences between the antibiotics used were significant. In the case of erythromycin, information on the pharmacokinetic features of this drug in camels is needed.

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Résumé

Younan M. Traitement parentéral de mammites à *Streptococcus agalactiae* chez le dromadaire (*Camelus dromedarius*) au Kenya

Des infections de la mamelle à *Streptococcus agalactiae* ont été traitées par voie intramusculaire sur une période de trois jours avec trois antibiotiques différents chez neuf femelles dromadaires (*Camelus dromedarius*) afin d'évaluer si ce mode d'application agissait au niveau de l'infection du quartier. Trois femelles ont reçu chacune une association à base de benzylpénicilline procaïne dihydrostreptomycine (12 millions UI/12 g/jour), trois autres ont reçu du pénéthamate iodhydrate (10 millions UI/jour) et les trois dernières de l'érythromycine (10 mg/kg/jour). La pénicilline-streptomycine a éliminé *S. agalactiae* dans trois des quatre quartiers infectés, le pénéthamate iodhydrate a eu un effet curatif dans deux quartiers sur quatre, alors que l'érythromycine n'a pas modifié l'infection des trois quartiers par *S. agalactiae*

Mots-clés : *Camelus dromedarius* – *Streptococcus agalactiae* – Mammite – Thérapeutique – Kenya.

Resumen

Younan M. Tratamiento parenteral de la mastitis por *Streptococcus agalactiae* en dromedarios kenianos (*Camelus dromedarius*)

Se trataron infecciones intra mamarias por *Streptococcus agalactiae* en nueve dromedarios (*Camelus dromedarius*), mediante un curso de inyecciones intramusculares de tres días con tres antibióticos diferentes, con el fin de definir si esta vía de aplicación tuvo efecto sobre el estadio de infección del cuarto. Se utilizó una combinación a base de dihidroestreptomycina-benzilpenicilina procaínica (12 millones UI/12g por día), hidroyoduro de penetamato (10 millones UI por día) y eritromicina (10 mg/kg por día), en tres grupos de tres dromedarios respectivamente. La penicilina-estreptomycina eliminó el *S. agalactiae* en tres de cuatro cuartos infectados, el hidroyoduro de penetamato tuvo efecto curativo en dos de cuatro cuartos infectados, mientras que el tratamiento con eritromicina no alteró el estadio de la infección de ninguno de los tres cuartos infectados con *S. agalactiae*.

Palabras clave: *Camelus dromedarius* – *Streptococcus agalactiae* – Mastitis – Terapia – Kenia.