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Efficiency of different therapeutic protocols in treating digital dermatitis in dairy cows

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ABSTRACT

The aim of this study was to evaluate the topical action of oxytetracycline (OTC) and copper sulphate ($CuSO_4$) in digital dermatitis treatment (DD). A study was conducted on a high-yielding dairy herd, to estimate the topical antibiotic effect and non-antibiotic treatment of DD, with or without bandaging. Research was carried out on 171 Holstein cows with DD in this study. The cows were divided into four experimental groups and one control group. In all cases, surgical debridement of DD lesions was performed before treatment. Group 1 received local topical treatment with oxytetracycline three times, on the zero, second and fifth days, without bandaging. Group 2 received one topical treatment of oxytetracycline with bandaging. Group 3 received one topical treatment of 8% copper sulphate. Group 4 received one topical treatment of 8% copper sulphate, followed by bandaging. Group 5 was used as the control, to assess the possible effects of surgical debridement and bandaging. The most efficient result was obtained in Group 2, in which 86% of the animals recovered from DD. Bandaging is a very important part of DD therapy, because it protects the layers of skin exposed after surgical debridement.

Key words: digital dermatitis, dairy cows, oxytetracycline, copper sulphate

Introduction

Digital dermatitis (papillomatous digital dermatitis, or footwarts) is a infectious disease of the feet in dairy cows. It was first reported in Italy in 1974, (CHELI and

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MORTELLARO, 1974) and since then has been reported in countries throughout the world (BLOWEY and SHARP, 1988). Recent studies conducted in The Netherlands have identified DD in 91-100% of herds and 21-26% of cows (SOMERS et al., 2003; HOLZHAUER et al., 2006), which is considerably higher than the prevalence found in a similar field study more than 15 years ago (FRANKENA et al., 1991; KOS et al., 2006).

Digital dermatitis mostly occurs on the plantar rear surface of the foot, affecting the skin adjacent to the interdigital cleft or the skin-horn junction of the heel bulb. Occasionally, lesions are found adjacent to the dew claws or bordering dorsal interdigital clefts (BLOWEY and SHARP, 1988; VAN AMSTEL et al., 1995). Most lesions are circular or oval, have a strawberry-like appearance, and are clearly demarcated by borders, with longer hair growing around the lesions, which have a distinctive odour (CORNELISSE et al., 1981). Left untreated, painful ulcers develop and erode hoof tissue (READ et al., 1992). In addition to animal welfare concerns, DD causes significant economic loss through animal weight loss, decreased milk production, premature culling and the expense of treatment (BLOWEY, 1998; HERNANDEZ et al., 2001). The effects of milk loss, decreased fertility and treatment are US$216 per cow, in which the cost of treatment forms the main component of the total cost per animal (42%), followed by the effects of decreased fertility (31%) and milk loss (27%) (CHAA et al., 2010). The etiology of DD is not clearly understood, but it is considered to be multi-factorial (READ and WALKER, 1998a; WELLS et al., 1999). Risk factors related to a high prevalence of DD are wet floors, replacement stock purchase, restricted grazing time, low parity, early lactation and serious heel horn erosion (WELLS et al., 1999; RODRIGUEZ-LAINZ et al., 1996a; TOHOLJ et al., 2008; BARKER et al., 2009). A precondition of DD seems to be spirochetes, or the presence of the genus *Treponema* (READ et al., 1992; CHOI et al., 1997). Although DD is a poly-microbial infection, anaerobic spirochetes belonging to the genus Treponema have been found consistently in DD lesions (READ et al., 1992; COLLIGHAN and WOODWARD, 1997). *Treponema phagedenis*-like (TPL) spirochetes are of particular interest, because these bacteria are localized deep within DD lesions, near the interface with healthy tissue (MOTER et al., 1998). Furthermore, cattle with DD demonstrate specific humoral and cell-mediated immune responses to TPL spirochetes (TROTT et al., 2003). Combined, these studies suggest TPL spirochetes are important to the development of DD lesions. Early reports indicate that DD lesions respond to treatment with topical antibiotics, thereby supporting a bacterial etiology hypothesis (BRIZZI, 1993; GRAHAM, 1994; GUARD, 1995; GUTERBOCK and BORELLI, 1995). Non-antibiotic products have been also reported to be efficacious (BRITT and McCLURE, 1998; HERNANDEZ et al., 1999). Parenteral antibiotics have not been consistently effective. The transition between the different stages of DD based on lesion development have been described (HILLSTRÖM and BERGSTEN, 2005; MANSKE et al., 2002). Left untreated, the duration of a single case of DD has been reported to be approximately 70 days (LOSINGER, 2006). SOMERS et al. (2005) reported that

ulcerative lesions may persist for several months. Knowledge of the duration of lesions is of value in creating incidence estimates from prevalence data (NIELSEN et al., 2009).

The purpose of this study was to examine the effectiveness of a single topical application of oxytetracycline, with bandaging, as a treatment for digital dermatitis, compared with the results of triple oxytetracycline application without bandaging, and the application of copper sulphate, with or without bandaging, in order to find out the most appropriate therapy in dairy farms with poor animal housing conditions.

Materials and methods

The presence and clinical presentation of DD in the hind limbs of 171 Holstein-Friesian dairy cows examined in a chute or milking-parlour were recorded weekly over a 4 week period in December 2009. The cows were divided into four treatment groups and one control group (Table 1).

Table 1. Dairy cows in experiment

Groups	No. of cows	Milk yield (L/y)	Age (years)	DD lesions assessment No. of cows	
				initial	advanced
G_1	38	6780 ± 432	3.7 ± 1.39	12	26
G_2	36	7654 ± 276	4.1 ± 1.23	11	25
G_3	31	7321 ± 564	3.9 ± 1.72	15	16
G_4	33	6645 ± 872	4.4 ± 1.56	11	22
G_5	33	7322 ± 745	3.8 ± 1.12	9	24

DD was recorded using a standardized scoring system comprising five stages (M0-M4), (BRITT et al., 1999), (Figs. 1a-d). M0 indicates feet with normal digital skin where DD is absent macroscopically. M1 is an early stage lesion (0-2 cm diameter) that is not painful upon palpation. M2 is the classic ulcerative stage with a diameter >2 cm, often painful upon palpation. M3 is the healing stage after local treatment, when the lesion is covered with a scab. M4 is the chronic stage, characterized by dyskeratosis or surface proliferation, generally not painful upon palpation. If different stages of DD were present, the foot was classed according to the most prominent stage of lesion. Both M2 and M4 lesions were considered as infectious stages of DD and these stages have been shown to carry *Treponema* spp. on the surface (MUMBA et al., 1999). M2 was considered to be the most infectious and painful stage and therefore taken as the outcome variable for DD in any further data analysis. M2 and M4 were considered as advanced stages of lesions while M0 and M1 were the initial lesion stages.

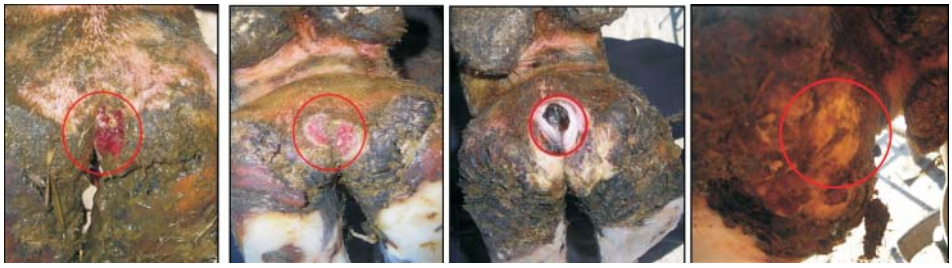

Fig. 1. Different clinical presentations of digital dermatitis. M_1 lesions - less than 2 cm in diameter, not painful when touched; M_2 lesions - typical ulcer formation with diameter more than 2 cm, often very painful upon palpation and very prone to bleeding; M_3 lesions - healing stage of digital dermatitis after treatment or spontaneous resolution; lesions are often covered with scabs; M_4 lesions - chronic presentation of digital dermatitis with proliferation or dyskeratosis of surface with lesions elevated above the surrounding tissue (photo by: B. Toholj, 2009).

Foot examinations. Clinical examinations were performed by one of the four authors of this paper, by using homogeny protocol to evaluate reactions after treatment (BRITT et al., 1999). The authors who had been involved in diagnosis and assessing treatment reactions were all highly trained and had wide experience in detecting lameness in dairy cows. A common scale regarding the criteria for recognizing different diagnosis stages was agreed before starting the experiment, in order to achieve a fair scoring system. To facilitate inspection, the rear feet were cleaned, if necessary, and water, brushes and paper towels were used to clean the dew claws. The data recorded were the affected claw, the diameter, type and location of lesions, and the level of pain in response to firm pressure with one thumb. In addition, daily inspections, as part of on-site farm lameness management, were carried out to detect permanent leg lifting, walking cautiously, resting on the hoof tip, or a typical smell, all of which might have indicated the presence of M2 lesions. Hoof and leg hygiene assessment was performed using a 1-4 scoring system (COOK, 2005), whereby 1 indicated good housing conditions and 4 very poor conditions. This system of scoring was based on an assessment of how manure contaminates limbs.

Treatment. Surgical treatment involved removal of all necrotic tissue, granulomas, and any remaining compromised tissue, including from the *stratum corneum*. After debridement, animals were divided into 2 groups, according to the lesion stage (initial M1, or advanced M2, M4). Then they were randomly divided into 4 groups of about 35, for treatment to be received postoperatively. Each group contained an equal number of animals from the 2 categorized groups of lesions. Group 1 (G1) received local topical treatment using an oxytetracyclin spray (Aueromycin®, Fort Dodge, Spain) on the zero, first and fifth days. Group 2 (G2) received one local topical treatment using an oxyteteracycline spray, followed by bandaging with sterile gauze for the first layer, and

hoof tape (Kromberg®, Kerbel, Germany) for the second layer. Group 3 (G3) received local topical treatment with 8% CuSO4 (Zorka®, Šabac, Serbia), covering lesions in copper sulphate powder in jelly form. Group 4 (G4) received local topical treatment with an 8% water solution of copper sulphate, covering lesions with copper sulphate powder in petroleum jelly. This group was bandaged using the method described for group 2. Group 5 (G5) was used as the control group, to assess the possible effects of surgical debridement and bandaging.

Statistical analysis. Statistical analysis was carried out using Statistica 5.0. Software (StatSoft, USA). Significances were tested using the T-test of dependent samples, with confidence intervals 95 and 99%.

Results

The surgery, in combination with hoof cleaning, removed all the necrotic and devitalized tissue, which hypothetically facilitated tissue airing and recovery. The most significant recovery (86.1%) was obtained in G2. The recovery of Group 1 was significantly lower (53%) than Group 2. In Group 3, 32.3% of the animals recovered; this group had the lowest results in a comparison of the treatment groups. In Group 4 (G4), the percentage of animals which recovered was 54.83%. The control group (G5) had the lowest results in the healing process, with 15.15% percent of animals recovering.

Table 2. Efficiency of different therapeutic protocols for digital dermatitis therapy

Groups	Treatment	No. of cows	No of recovered cows	% of recovered cows	% of non recovered cows	Significance P
G_1	otc	38	21	55.26*	44.74	<0.05
G_2	otc + bandaging	36	31	86.1**	13.9	<0.01
G_3	$CuSO_4$	34	11	32.3*	67.7	<0.05
G_4	$CuSO_4$ + bandaging	31	17	54.83*	45.17	<0.05
G_5	bandaging	33	5	15.15 ^{ns}	84.85	>0.05

ns - non-significant; *P<0.05; **P<0.01

About 85% of cows scored 3 and 4 in the hoof and leg hygiene scoring system, which indicated very poor housing conditions (Table 3).

Table 3. Hoof and leg hygiene scoring system results

Hoof and leg hygiene score	Proportion of cows scoring 1-4 (%)	Hygiene level
1	0	good
2	15	fair
3	13	poor
4	72	very poor

Discussion

Digital dermatitis (DD), also known as interdigital papillomatosis, is an apparently contagious, painful, inflammatory wart-like condition of the skin and bovine digit, the etiology of which is not clearly understood (READ and WALKER, 1994). There are strong reasons for believing that digital dermatitis is an infectious condition that is highly contagious, of complex etiopathogenesis, and of multifactorial origin, in which the role of bacteria is highlighted. One consistent finding is the prevalence of spirochete-like bacteria in the lower layers of the dermis, which may be a predominante morphotype (BLOWEY, 1998; READ et al., 1992). Electron microscopy and phylogenetic analysis have identified these spirochetes as *Treponema* spp., (*T. phagendis, T. denticola* and *T, vincentii*), (CHOI et al., 1997; DEMIRKAN et al., 1998; EDWARDS et al., 2003; TROTT et al., 2003). Digital dermatitis is highly multifactorial and many risk factors (related to environment, management and genetics) have been identified. Despite many discoveries, it is clear that current understanding of the etiology, pathogenesis and epidemiology of digital dermatitis is far from complete. In this situation, control measures have concentrated primarily on treatment and improving environmental hygiene. These have been often applied empirically, and they are highly divergent. There are several different approaches to the treatment of digital dermatitis; through systematic antibiotics, individual topical treatment, or group topical treatment (HERNANDEZ et al., 1999; LAVEN, 2006). Spontaneous recovery from digital dermatitis seldom occurred in our exanimations. Therefore, it was considered essential to use a wide-spectrum antibiotic, such as oxytetracycline, during the post-debridement period. In this study, we found that OTC has moderate effectiveness if used after surgical debridement without bandaging. The surgical removal of lesions is very helpful, especially in the advanced proliferation stage. It should be emphasized that regular claw trimming is mainly advocated as an adjunct for all types of treatment. OTC effectiveness increased greatly in Group 2, in which cows received a single dose of OTC, and immediate bandaging. The bandages were made of waterproof material, shielding the site from moisture and contamination during the healing process. Many studies have demonstrated a clinical response to antibiotics applied in the form of a topical spray treatment (BERRY et al., 1996). Non-antibiotic products have also been reported as effective (BRITT and McCLURE, 1998; HERNANDEZ et al., 1999; READ and WALKER, 1998b; LAVEN and HUNT, 2002; STEVANČEVIĆ et al., 2009). Products used included formaldehyde, copper sulphate, peroxide-based products, peracetic acid, zinc sulphate, etc. (BLOWEY, 1998; NUTTER and MOFFITT, 1990). This study demonstrates the possible impact of humidity, faeces and urine contamination on the efficiency of OTC. Copper sulphate is similarly effective if used in conjunction with bandaging and petroleum jelly. Oxytetracycline has been proved effective in the treatment of DD, but some factors may be limited by the mechanism of various actions. Bandaging hoofs after surgical debridement and topical antibiotic treatment is very useful; especially when faeces and urine are present on walking

areas, corridors, etc, due to poor hygiene maintenance. Research into the environmental predispositions of DD has suggested that certain herd-level or management practices predispose dairy herds to infection. These factors include large herd sizes, moisture in the corrals where cows walk, and the introduction of dairy replacement heifers in operations (RODRIGUEZ-LAINZ et al., 1996a,b). Increased understanding of the causal factors of this disease would facilitate the development of management strategies to prevent or minimize disease and resulting economic losses (ETTEMA and ØSTERGAARD, 2006).

In conclusion, most of the animals recovered, but only in the groups in which a combination of treatments was employed. The lower effectiveness of antibiotics and disinfectants were noticed even when triple applications, including debridement, were performed. As the prevalence of digital dermatitis in a herd increases, treatments combining surgery with the topical use of medication, in spite of being expensive and time-consuming, are the most efficient method of treatment. Further investigations are needed to discover the most appropriate forms of treatment in different housing conditions, because where housing conditions are satisfactory (well designed manure removal and drainage system) the topical application of medication without bandaging may be effective in the treatment of DD.

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SAŽETAK

Cilj ovog rada bio je istražiti djelovanje lokalno primijenjenog oksitetraciklina i bakrenog sulfata u liječenju digitalnog dermatitisa krava. Istraživanje je provedeno na farmi mliječnih krava, a procjenjivana je učinkovitost liječenja antiboticima i neantibiotskim tvarima s uporabom povoja ili bez. Istraživanje je provedeno na 171 kravi holštajnsko-frizijske pasmine. Krave su bile podijeljene u četiri pokusne i jednu kontrolnu skupinu. Prije medikamentozne terapije vršena je primarna kirurška obrada lezija koja je podrazumijevala uklanjanje nekrotičnog tkiva, tkivnih proliferata, dlake, eksudata i sl. Skupina 1 bila je liječena oksitetraciklinom u spreju trokratno bez primjene povoja. Skupina 2 bila je liječena oksitetraciklinom u spreju, lokalno. Nakon nanošenja antibiotika, lezija je bila prekrivena povojem. Skupina 3 bila je obrađena 8%-tnom otopinom bakrenog sulfata, a skupina 4 bakrenim sulfatom uz previjanje. Skupina 5 poslužila je kao kontrolna skupina gdje je procjenjivan utjecaj debridmenta i povoja. Najbolji učinak liječenja bio je uočen u skupini 2 gdje se liječenje sastojalo od ukljanjanja propalog tkiva, jednokratnog lokalnoga nanošenja tetraciklina i postavljanja povoja. U skupini 2 učinkovitost terapije iznosila je 86,1%. Postavljanje povoja nakon kirurškog debridmenta i primjena lijekova pokazala se uspješnom u liječenju digitalnog dermatitisa.

Ključne riječi: digitalni dermatitis, krave, oksitetraciklin, bakreni sulfat