JIDC | THE JOURNAL OF INFECTION IN DEVELOPING COUNTRIES

Original Article

An outbreak of dermatophilosis and caseous lymphadenitis mixed infection in camels (*Camelus dromedaries*) in Jordan

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Abstract

Introduction: This study describes and reports, for the first time, an outbreak of dermatophilosis that occurred concurrently with caseous lymphadenitis involving two camel herds (*Camelus dromedaries*) in north Jordan.

Methodology: The affected animals were part of two herds comprising 52 Arabian camels in herd 1 and 65 camels in herd 2. The age of infected camels ranged from 18 months to 5 years. Pus and skin scab samples were aseptically collected and bacteriologically examined. Affected camels were treated by long-acting oxytetracycline injection in a dose rate of 10 mg/kg body weight every 48 hours for three successive treatments, and local antiseptic and antibiotic cutaneous spray treatment for five successive days.

Results: The main clinical signs on affected camels were skin dermatitis and abscess formation. The isolated organisms were *Dermatophilus congolensis* and *Corynebacterium pseudotuberculosis* were the causative agents of dermatophilosis and caseous lymphadenitis, respectively. Other organisms were isolated from skin abscesses, including α-hemolytic streptococci, hemolytic *E. coli*, *Actinomyces pyogenes*, and *S. aureus*. The affected camels were rapidly and effectively cured by the above-mentioned treatment protocol. No mortality was recorded.

Conclusions: Introducing purchased camels from animal auctions without pre-examination and keeping camels in over-crowded small barns under cold, humid, and rainy conditions during winter may predispose the eruption of mixed infection of dermatophilosis and caseous lymphadenitis. Treatment by long-acting oxytetracycline injection with local antiseptic and antibiotic cutaneous spray can control such infection. A survey on camel herds raised near Jordan's borders is needed to monitor the possibility of emerging infectious disease.

Key words: *Camelus dromedaries*; dermatophilosis; caseous lymphadenitis; dermatitis; Jordan

J Infect Dev Ctries 2016; 10(5):506-511. doi:10.3855/jidc.7023

(Received 19 April 2015 – Accepted 10 June 2015)

Introduction

Dermatophilosis, also called mycotic dermatitis or streptothricosis, is a contagious zoonotic skin disease, an acute or chronic exudative epidermatitis caused by a pleomorphic Gram-positive, aerobic *Actinomyces* bacterium called *Dermatophilus congolensis* [1,2]. The condition has been described in a wide range of animal hosts and humans [3,4]. The most affected domestic animals are cattle [5], camels [6,7], horses [8], sheep [9], goats [10], occasionally cats [11], and other species [4]. In camels, a mixed infection of *D. congolensis* and *Microsporum gypseum* has been reported [12]. Experimental infection with *D. congolensis* isolated from cattle has been described in camels, cattle, goats, sheep, donkeys, and rabbits [13,14]. Transmission follows the disruption of the natural skin barriers by skin abrasions from thorns, grain awns, ticks, and flies. Prolonged wetting of skin during or after the rainy season may predispose camels to more severe infection because of the emulsification of the wax barrier and disruption of the stratum cornium. Human infection, in the form of pustules, furuncles, or desquamative eczema of the hands or forearms or superficial erosions of the esophagus, can be acquired through contact with diseased animals [7,15]. Camel dermatophilosis has been reported in Kenya, Sudan and Saudi Arabia [16], United Arab Emirates [17], Egypt [18], Ethiopia [19], Iran [20], India [21], and Belgium [5].

A skin disorder of high prevalence was observed among two herds of camels in a region of Ramtha province in north Jordan, near the Syrian border. This study describes a mixed infection outbreak of dermatophilosis and caseous lymphadenitis in camels in Jordan.

Methodology

Herd history

This study involved two herds of camels raised in a semi-desert and drought area near Ramtha city, located in the north part of Jordan. The condition was referred

to as representative of problems of dermatitis and abscess formations on various parts of the camels' bodies. The owners indicated that the camels had acquired this skin condition suddenly in winter 2012/2013, and that they had not seen it before despite having worked raising camels for over 30 years in this area. The affected animals were part of two herds comprising 52 camels in herd 1 and 65 camels in herd 2. Other animals, such as sheep, goats, and cattle live in the same vicinity and are separated from camel herds by wire-silk fences. All animals are raised for slaughtering purposes. The owners usually slaughter one to three camels weekly at a local slaughterhouse at Ramtha province and replace the herds by buying camels of different ages from animal auctions located in different parts of Jordan. The prevailing weather conditions at the time of examination were cold and rainy. Generally, the weather conditions at Ramtha province are humid and rainy during winter and dry and hot during summer. All camels were kept in overcrowded small barns and fed concentrate. Water was available ad libitum.

Clinical examination

Routine clinical examinations of all affected camels were performed, with special emphasis on the skin. Evaluation of the general state of the affected camels, temperature, appetite, morbidity, and mortality rates were recorded. Affected camels were treated with long-acting tetracycline in a dose of 10 mg/kg body weight (Liquamycin LA-200, Pfizer, Newyork city, USA) by intramuscular injection every 48 hours. Affected skin was treated locally with antiseptic and then dressed with antibiotic spray (Engemycin spray, Intervet, Kempton Park, South Africa) daily for five days. Local abscess were drained and irrigated by tincture of iodine daily for three days.

All work done in this study and the consent form read and signed by camel herd owners before sampling were approved by the institutional animal care and use committee.

Sampling and culturing

Samples of camel fibers and scabs were taken from camels with active cutaneous lesions on different parts of their bodies and investigated for the presence of *D. congolensis*. Each sample was suspended in 10% potassium hydroxide (KOH) and examined microscopically for the presence of dermatophytes. Smears prepared from the scabs and fibers were stained with Giemsa or methylene blue and examined for the presence of *D. congolensis*. The samples were also emulsified with Ringer's solution and inoculated on 5% sheep blood agar (Oxoid, Basingstoke, UK) plates. After aerobic incubation with the presence of 5% CO_2 at 37°C for 48 hours, *D. congolensis* revealed small greyish-yellow colonies, 1–2 mm in diameter, rough, convex, with complete zone of hemolysis, and attached firmly to the surface of the agar. After incubation for 3–4 days, the colonies became more wrinkled and the yellow pigmentation more intense. Grown colonies were emulsified with Ringer's solution and inoculated into sugar tubes, gelatin, litmus milk, indole, urease, and tested for catalase production [22-24]. The characteristics of the collected isolates were compared with that of *D. congolensis* (van Saceghem) Gordon ATCC 14637 as a control.

In addition, pus specimens were aspirated aseptically from camels with cutaneous abscesses from the two herds. A total of 11 pus specimens were collected from the two herds, 7 from the first herd and 4 from the second herd. All specimens were cultured on 5% sheep blood agar and on MacConkey agar media (CONDA, Spain, Madrid). Blood agar plates were incubated in a candle jar (3%–5% CO_2), and MacConkey agar plates were incubated aerobically. Both inoculated media were incubated at 37°C for 24–48 hours. Pus smears were done and stained with Gram stain and Albert stain. Identification of the isolated bacteria was based on morphology, culture characteristics, and biochemical reactions as described by [25]. All specimens were sent to the Bacteriology Research Laboratory at the Faculty of Veterinary Medicine, Jordan University of Science and Technology, within 2–4 hours of collections, where the work was completed.

Statistical analysis

Chi-square analysis was used to test the significant differences among herd 1 and herd 2 infections and between dermatophilosis infections among different age groups in both herds. A p value of < 0.05 was considered significant.

Results

Prevalence and historical findings

The owners indicated that the condition appeared in two young camels introduced newly to the herds. The first signs of the condition were seen in late January, following rainy days, and then the condition started to spread between the camels. Both males and females were affected. The *D. congolensis* affected 22 of 52 (42.3%) camels in herd 1 and 26 of 65 (40.0%) in herd 2. The affected animals were between 1.5 and ≥ 5 years of age. The prevalence of dermatophilosis was

Figure 1. A reddish-pink area of cutaneous ulceration following the removal of the superficial necrotic materials caused by *D. congolensis* in a 2-year-old camel.

Figure 2. Two abscesses, one open, on neck of a 3-year-old camel suffering from caseous lymphadenitis. *Actinomyces pyogenes* and hemolytic streptococci were isolated.

significantly higher in young camels (1–2 and 3–4 years of age) compared to the ≥ 5 years age group ($p < 0.05$). The prevalence of caseous lymphadenitis cases among camels of different ages was 13.5% in herd 1 and 6% in herd 2, as shown in Table 1.

Clinical findings

Camels infected with *D. congolensis* showed exudative skin inflammatory reaction characterized by enlargement of the slow-growing epidermis away from the corneum, which allows growth of a new layer of epidermal cells (Figure 1).

Abscesses were observed in the neck and belly regions of affected camels with caseous lymphadenitis (Figure 2).

After treatment with oxytetracycline injection, local antiseptic, and antibiotic skin spray, the response was high (Figure 3), and no mortality was recorded.

The pus materials taken from abscesses located on various parts of the body were thick viscous fluids creamy-white in color and sometimes tinged with blood. By Gram stain, Gram-positive cocci appeared in single, pairs, and short chains. One specimen revealed mixed culture with large colonies surrounded by a greenish zone of hemolysis on the inoculated blood agar plate. These large colonies were growing on MacConkey agar and show large, pink, round, smooth colonies. Staining revealed Gram-negative short rods. The bacterial growth from the other four pus specimens was only obvious after 48 hours of incubation in a candle jar and showed pinpoint hemolytic colonies and

Table 1. Cases of dermatophilosis and caseous lymphadenitis mixed infection in two camel herds in north Jordan.

		Examined specimens	Prevalence of infections			Total
			Age			
			1–2 years	3–4 years	≥ 5 years	
Herd 1	Dermatophilosis	22 skin scabs	8/12	12/14	2/26	22/52 (42%)
	Caseous lymphadenitis	7 pus	3	2	2	7/52 (13.5%)
Herd 2	Dermatophilosis	26 skin scabs	5/8	20/20	1/37	26/65 (40%)
	Caseous lymphadenitis	4 pus	1	2	1	4/65 (6%)
Total dermatophilosis			**13/20[1]**	**32/34[2]**	**3/63[3]**	**48/117 (41%)**

[1, 2, 3]: The prevalence of dermatophilosis was significantly higher in groups 1 and 2 compared to age group 3 ($p < 0.05$).

hemolytic, dry, granular, yellow-pigmented colonies. By Albert stain, black metachromatic granules were observed. By Gram stain, the organisms appeared to be pleomorphic Gram-positive curved rods with one end swollen and the other pointed. Some showed beaded short rods. Isolates from four specimens showed creamy-white large colonies; three of them were β-hemolytic and the fourth was non-hemolytic. By Gram stain, they were Gram-positive cocci. The isolated bacterial species are shown in Table 2.

Diagnosis

Direct smears of skin scabs revealed the presence of branched filaments, 2–5 mm in diameter, dividing both transversely and longitudinally into pockets of coccoid forms, in multiple rows, which is the typical morphology and diagnostic appearance of *D. congolensis*. The inoculated blood agar plates, after aerobic incubation in the presence of 5% CO_2 at 37°C for 48 hours, showed greyish-yellow, 1–2 mm in diameter, rough, convex, with ß-hemolysis colonies that attached firmly to the agar surface. *D. congolensis* was identified depending on the results of the biochemical reactions of the isolated colonies. The isolated *D. congolensis* was ferment sugars; glucose, fructose, maltose, sucrose, salicin and xylose, and gave positive results for gelatin, litmus milk, urease and catalase production, and it was indole negative.

Table 2. Bacterial species isolated from eleven cases of cutaneous abscesses from two camel herds in north Jordan.

Bacterial species	Number of isolates
First herd	
Dermatophilus congolensis	5
Actinomyces pyogenes	1
Hemolytic streptococci	3
Escherichia coli	1
Second herd	
Dermatophilus congolensis	4
Actinomyces pyogenes	2
Actinomyces pseudotuberculosis	1
Staphylococcus aureus	4

Discussion

Camel dermatophilosis is usually expressed in one of two clinical forms: acute or chronic. The acute form is called "rain scald", and is observed on the upper body where the long hair in the vicinity of the exudate becomes matted together, yielding the characteristic "paint-brush" effect [26,27]. The chronic form is characterized by an exudative pustular dermatitis with the appearance of cutaneous nodules around the base of the neck, flanks, and legs. When the necrotic material is detached, a whitish-pink, hyperemic wound surface of variable size will appear. Clinical cases of mixed infection of dermatophilosis with caseous lymphadenitis or ringworm due to *Microsporum gypseum* have been recorded in camels [12]. Secondary bacterial complication to dermatophilosis has also been recorded in camels [2]. In the current investigation, an infection of dermatophilosis concurrently mixed with caseous lymphadenitis was reported for the first time; such an infection had not been reported previously in the literature. Caseous lymphadenitis is a chronic, suppurative disease caused by infection with *Actinomyces pseudotuberculosis*. The disease is common in sheep and goats. Also, high prevalence in camels has been reported in many parts of the world [28-31]. The primary cause is *Actinomyces pseudotuberculosis*. Other microorganisms less frequently isolated include *Actinomyces renale*, *Actinomyces ulcerans*, *Streptococcus* spp. group B, *Staphylococcus aureus*, *Staphylococcus* spp., *Rhodococcus equi*, *Shigella* spp., *Moraxella* spp., *Escherichia coli*, and *Histoplasma farciminosum*. The disease usually affects camels 1–3 years of age, and the incubation period may extend up to 3 months. In the current study, the prevalence of dermatophilosis was significantly higher in young camels (1–4 years of age)

Figure 3. A 2-year-old camel with healed lesions of dermatophilosis after treatment with tetracycline LA 200 and cutaneous tetracycline spray for five successive days.

compared to camels ≥ 5 years of age ($p < 0.05$), which is similar to the findings of other reports [14,16].

D. congolensis may be isolated in pure culture from clinical materials by streaking scabs or exudate, preferably from unopened pustules, directly to blood agar plates, and incubating aerobically in the presence of 5% CO_2 at 37°C for 48 hours. Immunofluorescence techniques have been applied to identify *D. congolensis* in infected tissues [32]. An enzyme-linked immunosorbent assay has been developed to determine the epidemiological prevalence of *D. congolensis* infection in sera of camels. However, cross-reaction with *Nocardia asteroides* or *Actinomyces* spp. has been reported [33]. Recently, a polymerase chain reaction (PCR) technique was applied for identification of *D. congolensis* [34].

Many antibacterial drugs, including penicillin, streptomycin, chloramphenicol, tetracycline, erythromycin, and sulfonamides, are affective. Intramuscular injection of long-acting oxytetracycline in a dose of 20 mg/kg body weight repeated every 72 hours cured the infected camels within two weeks. Such treatment results were previously reported [18]. Also, treatment by local application of diluted iodine solution, followed by covering the infected cutaneous lesions with antibiotic ointment, is recommended. Topical treatment with 1% potassium aluminum sulphate was found to be effective [8,32,35].

The control of dermatophilosis by vaccination has been partially successful in sheep [36-38] and even more so in bovines; this may also be applicable to camels in endemic areas.

Conclusions

This study described mixed infections of a dermatophilosis outbreak that were caused by *D. congolensis* (represented by exudative dermatitis) and caseous lymphadenitis (represented by cutaneous abscesses) in camels in Jordan. The abscesses were caused by multi-bacterial agents. Treatment with long-acting oxytetracycline injection in a dose rate of 10 mg/kg body weight every 48 hours for three successive treatments, and local antiseptic and antibiotic cutaneous spray treatment for five successive days was found to be effective and rapidly cured the affected camels. Monitoring of camel herds' skin infections in Jordan's desert and border areas may be required.

Acknowledgements

This work received financial assistance from the Deanship of Research, Jordan University of Science and Technology.

Authors' contributions

The clinical examination and treatment of camels was done at the camel herd owner's place, near Ramtha city, north of Jordan. The laboratory tests were executed at Research Microbiology Laboratory, Department of Basic Veterinary Medical Sciences, Faculty of Veterinary Medicine, Jordan University of Science and Technology, Irbid-Jordan. Prof. Al-Ani diagnosed the camel cases of the outbreak and Prof. Dr. Tarazi took the skin scraping and pus specimens, and conducted laboratory tests for identification of the bacterial causative agents of the outbreak. Both authors were involved in treatment and monitoring the camels and participated in writing, revising, and approving the article.

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Conflict of interests: No conflict of interests is declared.