LYME BORRELIOSIS IN CATTLE

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1. INTRODUCTION

Lyme borreliosis (LB) is an acute and persistent zoonotic infection caused by the spirochete *Borrelia burgdorferi* that is transmitted by *Ixodid* ticks.

The skin form of the disease in man, erythema chronicum migrans (ECM), was described initially in Europe in 1909 and subsequently in North America and Australia. The syndrome of ECM, together with cardiac, neurological and joint disease was recognized in Lyme, Connecticut, USA.

Borrelia burgdorferi was first isolated from the tick *Ixodes dammini* by Burgdorfer *et al.* (1982) and from ECM, blood and CSF of people with Lyme disease (1983).

A number of domestic animals (dogs, horses, sheep and cattle) have contracted Lyme disease. Wild animals (mice, voles, rabbit, deer, racoons, birds,...) are known to be reservoir hosts.

2. BACTERIOLOGY

Borrelia burgdorferi is the spirochete responsible for causing Lyme disease. To date, *B. burgdorferi* can be divided into at least 11 species. Of the 11 species constituting the complex *B. burgdorferi sensu lato*, only *B. burgdorferi sensu stricto*, *B. afzelii* and *B. garinii* are involved in clinical cases of Lyme borreliosis in mammals in Europe (EUCALB). *B. burgdorferi* is an aerobe, microaerophilic, motile, and spiral shaped bacterium, with two membranes. This bacterium is fastidious in its growth requirements. The determination of complete genome sequences of *B. burgdorferi ss* and *B. garinii* has been achieved in the recent past years.

The borrelial genome is unique among bacterial genomes in that it is composed of a linear chromosome and 21 linear and circular plasmids. The plasmids exhibit significant genetic redundancy and carry 175 paralogous gene families, most of unknown function. Some of them are essential for growth or survival in natural life cycle.

To date, only B. *burgdorferi* ss and *B. garinii* have been described in bovine Lyme disease. However, two other spirochetes, *B. theilerii* and *B. coriaceae* have been described in cattle and considered as the agent of bovine borreliosis and as the putative agent of epizootic bovine abortion, respectively.

3. CLINIC

A clear case definition of Lyme borreliosis in bovine is lacking and attributing clinical signs as a result of *B. burgdorferi* infection is particularly difficult. Experimental infection of cattle with the three main genotypes of Lyme borreliosis (*B. burgdorferi, B. garinii, B. afzelii*) failed to reproduce the disease and to induce any sign or symptom (Tuomi *et al.* 1998). As for dogs, it seems that a high percentage of cattle that are exposed to *Borrelia burgdorferi* do not show any clinical disease and remained asymptomatic.

Nevertheless, since the 1990's, it is possible to define different symptoms of Lyme borreliosis in cattle on serological and/or bacteriological basis.

In acute Lyme disease, cattle will often show non specific symptoms (fever, anorexia, asthenia) and stiffness, swollen joints or decreased milk production. (Parker *et al.* 1992). Chronic weight loss, distension of the carpal joints, laminitis and abortion are possible outcomes of borreliosis in cattle (Parker & White, 1992). Lameness is suspected to be a frequent sign of *Borrelia burgdorferi* infection in cattle, but the link between infection and clinical disease is rarely established in a conclusive manner.

Though erythema chronicum migrans, which is a characteristic symptom of human LB, is very rarely seen in domestic animal, some descriptions of skin lesions in cattle with LB exist. Erythematous lesions on the hairless skin of the udder have been described (Lischer *et al.* 2000). This erythema, characterised by warmth and swelling and hypersensitivity to touch of the udder skin could correspond to the local rash at the site of the tick bite. In addition, erythema of the interdigit skin has been described in some cattle (Blowey *et al.* 1994) and could be responsible for the lameness.

Lyme disease in cattle often occurs as a herd problem in first calving heifers when they go into full milk production (Parker & White, 1992).

4. LESIONS

Joint capsules are markedly thickened. The synovial villi are prominent. A large amount of amber to red joint fluid is present in distended joint. Sometimes, large pieces of blood stained fibrin are present. Lymph nodes can be swollen and oedematous.

Histologically, synovium is markedly hyperplastic with mononuclear cells infiltrate. Foci of of necrosis can be seen in different organs. Subacute interstitial pneumonia and membranoproliferative glomerulonephritis are described (Rothwell *et al.* 1989 ; Trapp, 1990).

5. EPIDEMIOLOGY

Many mammalian species have now been identified as reservoirs. The majority of these are rodents (*Apodemus spp, Clethrionymus spp, Sciurus…)*. The role of carnivorous species and lagomorphs is probably limited. Ungulates (deer, sheep, cattle, goats and pigs) are not involved into the infection of a high proportion of ticks that feed on them. They are, however, crucially involved in the ecoepidemiology of borreliosis as maintenance hosts for the ticks. Birds play certainly a significant role by infecting ticks at least with *B. garinii.* (EUCALB).

The finding that different genospecies have differential susceptibility to serum complement from particular host species *in vitro* may prove valuable in further defining the reservoir host spectrum of each genospecies (Kurtenbach *et al.* 2002).

B. burgdorferi is mainly transmitted to cattle by Ixodid ticks. The sheep tick, *Ixodes ricinus*, is the main vector for *B. burgdorferii* in Europe. *I. scapularis*, *I. pacificus* and *I. persulcatus* are the (main) vectors of *B. burgdorferi* in the USA and Eurasia.

However, another route of transmission of this bacterium has been proposed. *B. burgdorferi* has been isolated from cows urine (Burgess *et al.* 1987) and infection by the urine/oral route is postulated (this route of infection has been demonstrated experimentally using mammals belonging to *Peromyscus* species). Furthermore, transplacental transmission and transmission by infected milk are possible routes of infection, as *B.b.* has been detected in foetus and milk (Lischer, 2000).

6. DIAGNOSIS

6.1 Clinical

Diagnosis of clinical Lyme disease is difficult. Because the association between lameness and LB in cattle is not unambiguous, cows have to be examined carefully to rule out any other cause of lameness. Diagnosis depends on the recognition of clinical signs, on a history of possible exposure to the bacteria (for example by tick bite) and on the identification of the spirochete in the affected animal. (Parker & White 1992).

6.2 Isolation

Isolation of *Borrelia burgdorferi* is difficult because the bacterium is found in extremely low numbers in blood or tissue. Aseptically collected blood, CSF, synovial fluid, urine and colostrum can be examined under dark microscopy or cultured. Nevertheless, the presence of the spirochaete is not sufficient to ascertain Lyme Borreliosis diagnosis.

6.3 PCR

PCR with different primers can be applied on the same samples as for isolation. Classical and Real time PCR are available. This technique seems to be now the best tool (rapid, friendly and not expensive) for a conclusive diagnosis.

6.4 Serology

Serological testing is the only practical means for confirming *B. burgdorferi* infection.

A number of assays for antibody detection have been developed. These assays have not been standardized for bovine fluids. These tests can be performed on sera or other body fluids as CSF or synovial fluid.

IFA and ELISA with crude extracts of *B. burgdorferi* have been used.

The antibody titer threshold for seropositivity depends on laboratory experience (and on animal species?). Titers higher than 1/64 or 1/100 are generally considered as positive for cattle (Parker *et al.* 1992).

Various subunit or recombinant antigens are proposed for performing different WB tests. For serology applied to bovine sera, the antigens available are the 41kd flagellin (Ji *et al.* 1994) and different recombinant antigens (mostly outer membrane proteins of *B. burgdorferi* ss) (Magnarelli *et al.* 2004). Using ELISA or Western blotting, some of these recombinant antigens seem specific to *B. burgdorferi*.

However, in almost all studies, and whatever the test used, there was no significant difference between the seropositivity rates in healthy groups vs sick cattle groups, and the mean antibody levels were found similar for both groups.

Moreover, *B. theileri* infected calves produce antibodies that cross reacted with*B. Burgdorferi* and *B. coriaceae* whole-cell antigens. (Rogers *et al.* 1999).
Serology can be used to confirm cattle exposure to *B. burgdorferi sensu stricto*. Positive results to antibody tests are an aid to diagnosis but are not a conclusive indication of current infection or clinical disease. Assays results should always be interpreted in light of the clinical findings.

7. TREATMENT

The most frequently recommended antibiotics are:

- tetracycline (5 mg/kg: day) in articular form,
- penicillin G 20000 UI/kg day).

A course of 3 weeks of antibiotics is recommended. However, the duration of treatment does not fit generally with economic requirements.

8. PREVENTION

There is no vaccine for Lyme borreliosis in cattle. Tick and arthropod populations control is the major measure to prevent *B. burgdoferi* infection of cattle. A tick repellent should be used. Delthamethrin is available for bovine. The remanent effect of deltamethrin is about one month.

9. CONCLUSION

The knowledge about Lyme borreliosis in bovine is largely impaired by the lack of appropriate tools for diagnosis. New recombinant antigens for serology and a more frequent use of PCR will be of great interest for improving the diagnosis of Lyme borreliosis in cattle.

10. SUMMARY

Lyme borreliosis (LB) is an infection caused by *Borrelia burgdorferi* complex that is transmitted by *Ixodid* ticks. A clear case definition of Lyme borreliosis in bovine is lacking but lameness seems to be a frequent sign of *Borrelia burgdorferi* infection in cattle. A high percentage of cattle that are exposed to *Borrelia burgdorferi* remain asymptomatic. Serology can be used to confirm cattle exposure to *B. burgdorferi sensu stricto*. Assays results should always be interpreted in light of the clinical findings.

11. KEY WORDS

Borrelia, Lyme, cattle.

12. RESUME

La borréliose de Lyme est une entité clinique due, en Europe, à *Borrelia burgdorferi*, *B. garinii* et *B. afzelii*. Cette maladie est décrite chez différents mammifères dont les bovins. Différentes voies de transmission sont décrites. Dans cette espèce, les descriptions cliniques sont rares, en partie du fait de la difficulté à établir un diagnostic de certitude. Néanmoins, les atteintes articulaires semblent être une constante. Cependant les infections asymptomatiques semblent nombreuses et les outils diagnostiques ne sont pas suffisamment développés pour cette espèce. Le diagnostic repose donc sur l'association de signes cliniques, d'une situation épidémiologique favorable et de marqueurs biologiques.

13. MOTS CLES

Borrelia, Lyme, bovin.

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