Understanding the aetiology and infection reservoirs of digital dermatitis in beef cattle and sheep

Sullivan, L.E., 1 Carter, S.D., 2 Duncan, J.S., 2 Grove-White, D., 3 & Evans, N.J. 1

1Department of Infection Biology, Institute of Infection and Global Health. 2School of Veterinary Science, University of Liverpool, Liverpool, L69 7ZJ, UK.

Abstract

Digital dermatitis (DD) is an infectious hoof disease causing severe lameness in ruminants worldwide. The primary cause has been identified as the spirochaetal bacteria, treponemes. A comprehensive bacterial molecular survey of sheep contagious ovine digital dermatitis (C Dodd) lesions has not been done to determine if there is a shared epiopathogenesis between BDD and CDD. Also, there have been only anecdotal reports of BDD lesions occurring in beef cattle, with no definitive published data on the disease. Additionally, little is known about the transmission of Treponema bacteria. It may be possible that DD treponemes are carried in both cattle and sheep gastrointestinal (GI) tracts and then shed in faeces and spread. Another route of transmission may be via farm equipment.

This study investigated ruminant GI tissues and farm equipment for the presence of DD treponemes. Additionally, sheep and beef DD lesions were analysed for the presence of DD treponemes by PCR and culture techniques.

Introduction

• Digital Dermatitis (DD) causes ulcerative lesions of the digital skin which causes severe lameness in cattle and sheep.

• Bovine digital dermatitis (BDD) has been reported in dairy cattle in all countries where they are farmed and the disease has recently spread into sheep in the UK, known as contagious ovine digital dermatitis (C Dodd).

• The primary causative agents of DD = spirochaetal bacteria of the genus Treponema.[1]

• In the UK and USA three phylogroups have been isolated from dairy cattle lesions, which are described as "Treponema medium[Treponema vincentii-like]", "Treponema phagedenis-like" and T. pedis DD spirochaetes.[1]

• Commensal treponemes are commonly found in ruminant gastrointestinal (GI) tracts. However, preliminary evidence has also found the presence of DD treponemes in the bovine GI tract.[2]

• One item that regularly comes into direct contact with the feet of cattle and sheep is hoof trimming equipment, and in many herds, this can happen at least twice a year.[3] Therefore it may be possible that treponemes can be transferred from foot to foot via this equipment.

Methods

1. Beef cattle (n = 34) and sheep (n=58) DD lesions:

Subjected to culture and PCR analysis for the commonly detected DD treponemes. Culture of treponemes was attempted under anaerobic conditions in an anaerobic cabinet (Don Whitley, UK). For PCR analysis, DNA was extracted using a DNeasy kit (Qiagen, UK). PCR analysis was for the three DD treponeme phylogroups described previously.[1] PCR analysis was also carried out on healthy foot tissues.

1. Treponema detection and culture from sheep and beef GI tissues and faeces

<table>
<thead>
<tr>
<th>Beef Rectal tissue: n= 40</th>
<th>Sheep Rectal tissue: n= 40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef Gingival tissue: n= 40</td>
<td>Sheep Gingival tissue: n= 40</td>
</tr>
<tr>
<td>Beef Faeces: n= 41</td>
<td>Sheep Faeces: n= 79</td>
</tr>
</tbody>
</table>

3. Treponema detection and culture from hoof trimming equipment:

After the trimming of a hoof, the trimming instrument used was tested by swabbing across each side of the blade on both sides of the instrument. The trimming instrument was then rinsed in iodine disinfectant (containing 2.5% (w/v) available iodine), wiped with a clean cloth and then retested with a fresh swab using the same technique. DNA was then extracted and PCR analysis performed as per Method 1.

Cattle hoof knives tested: n= 24 (17/24 were DD+ animals)
Sheep hoof knives tested: n= 13 (9/13 were DD+ animals)
Total: 37 hoof knives tested after trimming animals hooves and after disinfection of the equipment.

Results

1. Beef and sheep DD lesions:

"T. medium[T. vincentii-like]", "T. phagedenis-like" and T. pedis spirochaetes, were identified in 39/58 (67%), 49/58 (85%) and 41/58 (71%) and 27/34(79%), 31/34(91%) and 24/34(71%) of CODD lesions and beef DD lesions, respectively.

One or more BDD-associated Treponema phylogroups were detected in 100% of DD lesions. Healthy foot tissues did not amplify DD-associated Treponema phylogroup DNA. 32 treponemes were isolated from CODD lesions and 20 from beef DD lesions. All belonged to the three DD-associated phylogroups except 1 from a beef DD lesion which may represent a new treponema taxa.

2. Sheep and beef GI tissues and faeces positive for DD treponemes:

<table>
<thead>
<tr>
<th>Beef Rectal tissue: 0/40</th>
<th>Sheep Rectal tissue: 3/40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef Gingival tissue: 4/40 (all &quot;T. phagedenis-like&quot;)</td>
<td>Sheep Gingival tissue: 1/40 (T. pedis)</td>
</tr>
<tr>
<td>Beef Faeces: 0/41</td>
<td>Sheep Faeces: 0/79</td>
</tr>
</tbody>
</table>

A "T. phagedenis-like" spirochaete was isolated from a sheep rectal tissue sample.

Eighteen Treponema isolates were obtained from sheep faeces, all sharing >98% sequence identity to the Treponema sp. CHPA (GU566699) previously isolated from the bovine GI tract.[1] No DD treponemes were isolated from faeces. All sheep and beef faeces were negative for DD specific treponemes.

3. Hoof trimming equipment:

A "T. phagedenis-like" spirochaete was isolated from a knife after trimming a DD+ cows foot.

After trimming, "T. medium[T. vincentii-like]", "T. phagedenis-like" and T. pedis DD spirochaetes, were shown to be present on 23/37 (62%), 21/37 (57%) and 20/37 (54%) of knives, respectively. After disinfection, detection rates for the DD treponemes were 9/37 (24%), 6/37 (16%) and 3/37 (8%), respectively.

Takeaway messages

• There appears to be little difference in treponeme detection rates between sheep CODD lesions, beef BDD lesions and previously studied dairy BDD lesions suggesting a shared aetiopathogenesis.

• Hoof trimming equipment appears to be able to harbour DD treponemes after trimming infected cattle and sheep feet and therefore disinfection of equipment after use is imperative to limit the spread of DD between animals and possibly between farms.

• These results suggest the GI tract as a possible means of DD Treponema carriage/transmission. The high isolation rate of Treponema sp. CHPA suggests this is a potentially prominent GI bacterial species in sheep. This species has only previously been isolated from a bovine rumen and in the same geographical area.[1]

References