Chlamydia and Chlamydophilia in small ruminants and other farm animals

Johannes Kauffold, a Axel Wehrend, b Haukur Sigmarsson, a Matthias Hoops 

a Large Animal Clinic for Theriogenology and Ambulatory Services, Faculty of Veterinary Medicine, University of Leipzig; b Clinic for Obstetrics, Gynaecology and Andrology of Large and Small Animals with Veterinary Ambulance, Justus-Liebig-University, Giessen, Germany

Abstract

Infection with Chlamydiae, specifically Chlamydophila (Cp.) abortus, causes enzootic abortion in small ruminants. The disease is highly prevalent in most parts of the world and has a high economic impact especially on the sheep industry. Swine is another species that can suffer from chlamydial infection. Besides Cp. abortus, Cp. pecorum and Chlamydia (C.) suis can all cause reproductive failure. Unlike in small ruminants, chlamydiosis usually occurs as a sporadic event. In swine, the disease has several clinical manifestations (e.g. abortion, endometritis, vaginitis, vulval discharge) and is considered a multifactorial disease. In both small ruminants and swine, males can also get infected and then become diseased, and may shed Chlamydiae with their semen. This contribution will briefly describe chlamydial infection in small ruminants and swine with specific focus on reproduction.

Keywords: Chlamydia, Chlamydophilia, small ruminants, swine, reproduction

Introduction

Chlamydiae are obligate intra-cellular gram-negative bacteria that cause different diseases in animals and humans. The bacteria is widespread in the cattle population were it can infect different organs or tissues and can cause several albeit mostly sporadic diseases including reproductive failure. This is similar to the situation seen in swine where intestinal and pulmonary but also genital infection can occur. In contrast, an infection in small ruminants usually leads to an enzootic disease with the main clinical sign of abortion. This contribution will briefly review the current knowledge on chlamydial infection in small ruminants and swine as the most susceptible large animal species, in addition to cattle, to chlamydial infection. Special emphasis will be put on clinical reproduction.

Chlamydia and Chlamydophilia in small ruminants

Prevalence and species

Chlamydial infection is prevalent in the sheep and goat population worldwide, except in Australia and New Zealand. The serological prevalence can vary in different countries and also between regions within a country. For instance, in a study conducted in Switzerland the overall flock sero-prevalence against Cp. abortus was 18.47% (118/639), ranging 4.4-41.0% for different regions within the country. In another study also conducted in Switzerland, sera from 775 randomly selected flocks out of 11 cantons were investigated and antibodies against C. abortus found in almost 19% (144) of the 775 examined sheep flocks. The predominant species in small ruminants is Cp. abortus, while Cp. pecorum can also be observed. In a study conducted in the Netherlands during five successive lambing seasons between 2006 and 2011, 453 submissions of abortion material, 282 of ovine and 171 of caprine origin, were examined at the Animal Health Service in the Netherlands. Infectious agents as the most plausible cause of the abortion were found in 48 percent of the ovine submissions and in 34 percent of the caprine submissions. Similarly, in another study coming from Switzerland where the causative situation of sheep and goat abortions was investigated, Cp. abortus was found in 39% of sheep and 23% of goat abortions.

Rams and bucks were also found serologically positive indicating previous Chlamydia exposure. In a Swiss study 34.8% of the rams (16/46) and 60% of the bucks (9/15) from different flocks were serologically tested positive for Cp. abortus. However, none of the rams or bucks had a Chlamydia positive semen result. In contrast, when rams were experimentally infected with Cp. abortus, they developed clinical disease and shed Chlamydiae with their semen.

Transmission

The infection occurs mostly orally with contaminated environmental material such as bedding material and feed, as well as with contaminated fomites. Diseased animals (i.e. after abortion; see below) will shed the bacteria through vaginal secretions, placentas and (dead or weak) fetuses. Lambs born to infected animals may also carry Chlamydiae and then serve as a vector. It is interesting to note that the viability of Cp. abortus in the environment can be variable, with weeks to months viability in dry straw or “dried up” placentas at cold ambient temperatures (during the winter months). The possibility of venereal transmission remains unclear.
Genital infection and clinical disease

*Cp. abortus* causes enzootic abortion is recognized as a major cause of reproductive loss in sheep and goats worldwide. In countries of Northern Europe, the disease is the most common infectious cause of abortion in small ruminants, accounting for approximately 20 to 45% of all abortions (based on data from Switzerland, Netherlands and UK).4,7,8 Stuen and Longbottom9 recently published a review in which they comprehensively described *Cp. abortus*-induced disease. Accordingly, an infection in animals is asymptomatic, displaying no specific premonitory signs of the impending abortion. Only some behavioral changes or a slight vaginal discharge may be observed in a few animals up to a couple of days before abortion.15,16 Regardless of when the infection occurs, the bacteria starts to invade the placenta at 90 days’ gestation and then causes suppurrative necrotizing placentitis. The first clinical sign of the endemic disease usually starts with the first delivery of dead lambs two to three weeks before the expected lambing. Aborted lambs appear normal and well-developed, but some may show a degree of edema giving rise to a “pot-bellied” appearance. The fleece may be discolored or covered with a pinkish-brown material that is usually a sign of delayed parturition and originates from meconium. The placental membranes can be necrotic.15,16 An infectious vaginal discharge may be observed for several days following abortion, but otherwise the animals are clinically normal and are considered immune to further disease lifelong. Retained placenta can be occasionally observed and is more frequent in goats than in sheep.17,18 This can result in the development of metritis and eventually, death due to secondary bacterial infections. In addition to abortion, animals may deliver stillborn or weak lambs that fail to survive beyond two days of age. Also, it is not uncommon for infected animals to deliver healthy lambs, with little necrotic damage evident in the placental membranes, as well as delivering one dead and one weak or healthy lamb.

There are not a lot of data available with respect to clinical disease in rams in bucks. Experimental infection with *Cp. abortus* has resulted in epididymitis in rams.10

In contrast to *Cp. abortus*, *Cp. pecorum* causes subclinical intestinal disease, but has however, also been reported to be involved in the conjunctivitis-arthritis complex, and may also cause pneumonia.20,21

Chlamydia and Chlamydophila in swine

Prevalence and species

*Chlamydiae* are widespread in female pig breeding stock worldwide. Serological testing revealed a prevalence of chlamydial infections ranging between 16.4% and 63.5%.22,23 Seroprevalence surveys conducted in several European countries indicated, however, different antigen pressure at different locations, even within the same country.33,24 Clearly, overall prevalence data only partially reflect genital tract infection, as many other organs besides the genital tract including intestines, lung, udder or joints can be colonized,25-28 and thus be the primary site of antibody response.29,30 Chlamydial DNA has been frequently detected in several female genital tract specimens, such as from cervical swabs, uterus, and oviductal tissues, and from aborted material. However, the rate of positivity varied considerably among studies and according to the examined specimens, ranged between 3.9% from fetal aborted membranes31 to 61.9% from uteri and oviducts of cull pigs.32 Chlamydia has also been detected in uteri of feral swine.33

There has not been as much testing on boars as on sows for the prevalence of *Chlamydiae*. However, seropositivity rate was equally high,27,30 and antigen pressure seems to vary also for boars, as seropositivity rates differed between studs.30 Raw semen samples were detected positive for *Chlamydiae*, however, the percentages of positive samples varied notably between 9.1 and 17.2%.34,35 Moreover, shedding in individual boars seems to occur inconsistently.35 Studies on *Chlamydiae* in the boar’s genitourinary tract yielded ambiguous results. Tenakum et al for instance, were unable to find *Chlamydiae* in testicles, epididymides, accessory glands, prepuce and urethra of 41 sexually active or virgin Swiss boars using 16S rRNA-PCR and immunohistochemistry.35 If, however, genitalily diseased boars were investigated, *Chlamydiae* could be detected within the genitourinary tract by either culture or PCR.36,37

Both *C. suis* (formerly *C. trachomatis*) and *Cp. abortus* were most frequently observed in genital tract tissues of female pigs. While *C. psittaci* and *Cp. abortus* predominated in cervical swabs38,39 and/or genital tract tissues,29,40 *C. trachomatis* was more frequently found in aborted material.41 A third species, *Cp. pecorum*, was retrospectively identified from cases of abortion.25,42 Moreover, *Cp. psittaci* (the avian strain of *C. psittaci*) has been detected in uteri and/or oviducts of culled sows40 and feral swine.33 Dual infections, such as with *C. trachomatis*/*Cp. pecorum*, *Cp. abortus/C. suis* and *Cp. psittaci/C. suis* are possible. Recently, *C. trachomatis* (a human strain) has been described in three specimens of the female genital tract,32 the relevance of this finding is, however, unclear. Besides *Chlamydiae*, Chlamydia-like organisms have been detected in cervical swabs, uteri, oviducts and aborted...
Chlamydia-like organisms were also found in semen, as well as dual infections observed.  

Transmission  
Transmission and genital infection has not been very intensively investigated in swine, and data are thus patchy and inconclusive. In general, infection in swine is assumed to occur oro-nasally after exposure to, or consumption of infected environmental material, but infection by the aerosol route is also possible. Chlamydia might then be systemically disseminated into the genital tract by the bloodstream through phagocytosing immune cells such as macrophages and monocytes. This extragenital route of genital infection has been advocated by the fact that gilts with very limited previous sexual contact were found Chlamydia-positive in genital tract tissues.  

In humans, genital chlamydirosis is one of the most significant sexually transmitted diseases worldwide. Infections occur reciprocally during sexual intercourse, but semen has been demonstrated to be the main vector. Moreover, female genital infection has been reproduced in several other species including primates, mice and guinea pigs, either by artificial genital inoculation or mating with infected males. In the pig, there is currently no conclusive evidence that female pigs acquire infection through infected semen, either through natural breeding or artificial insemination. However, chlamydial species found in the female genital tract were also found in semen. Moreover, if gilts were genitally inoculated with a human genitopathogenic strain of C. trachomatis, they developed severe genital pathology. It might thus be suggested, that venereal transmission is possible in principle. It is not known if boars can acquire infection from a genitally infected female during natural mating.  

Genital infection and clinical disease  
While there was an association between seropositivity and reproductive problems in some studies, a recent study failed to confirm this relationship. In contrast to serology, there seems to be a consistency among studies with respect to a positive relationship between the presence of Chlamydiae in the reproductive tract and reproductive problems.  

The entire porcine female genital tract seems to be susceptible to chlamydial infection, as co-incubation of genital cells harvested from the cervix, uterine body and uterine horns with C. suis strain S-45 led to infection of all three cell lines, albeit with different susceptibility. Generally, chlamydirosis in the female pig has been associated with a wide range of diseases including numerous reproductive disorders such as mummification, abortion, perinatal mortality, endometritis, vaginal discharge, repeat breeding as well as poor reproductive performance. In contrast to small ruminants, abortion in swine is a rather sporadic event, of which the pathogenesis is not clear. C. abortus, C. suis and C. pecorum have been detected in aborted material as single species or in combination. In general, C. abortus is assumed to be the primary cause of abortion in pigs. However, C. abortus does not seem to be obligately pathogenic in swine, as this species was also found in uteri of intact pregnant animals. The fact that different chlamydial species were found in the various oviductal segments (ampulla, isthmus and utero-tubal junction) of repeat breeder pigs suggests that the bacteria may have an effect on oviductal function as seen in women and laboratory animals. For instance, Chlamydiae may cause subtle ultrastructural alterations of the oviduct, such as deciliation or ciliary dysfunction, which could result in defective ovum capture and transport. Chlamydial infection of oviductal cells might also affect secretory patterns of those growth factors and cytokines presumably participating in events of fertilization and early embryonic development. Clearly, chlamydirosis in the pig breeding stock is a multifactorial disease with predisposing factors belonging to hygiene and confinement. Moreover, co-infection with other swine pathogens such as PCV-2 may also facilitate the occurrence of chlamydial disease including reproductive failure.  

Data on genital disease of boars as the result of a chlamydial infection are patchy, but it seems that the bacteria can cause an inflammation of the accessory glands and the testes.  

Conclusions  
Small ruminants as well as swine can be infected by Chlamydiae. While in small ruminants, an infection with C. abortus is endemic and leads to late-term abortion, infection in swine with Chlamydiae (C. abortus, C. pecorum,C. suis) does not necessarily causes a disease unless exposed to deleterious factor(s). The clinical picture in female swine is variable including abortion, endometritis, vaginitis and vulval discharge. Bucks and rams as well as boars can become infected and subsequently develop disease, with inflammation seen in the accessory glands, testes, and occasionally the epididymides. Shedding of the bacteria is possible and semen may serve as the vector for Chlamydiae.
References


