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Short communication

Development of maternal antibodies after oral vaccination of young female wild boar against classical swine fever

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Abstract

An experimental study was performed to investigate the development of maternal antibodies after oral immunisation of young female wild boar against classical swine fever (CSF) using C-strain vaccine. Our results demonstrated that maternal antibodies do not persist in the offspring for more than 3 months. Based on the neutralising serum antibody titres, we assume that piglets of wild sows vaccinated orally twice or immunised once a long time before conception have protective antibodies for approximately 2 months. Furthermore, it seems that the level and the duration of maternal antibodies in the offspring are depend on the age of the female animals at the moment of vaccination as demonstrated in our experiment. The recent vaccination procedure consists of three double vaccinations in spring, summer and autumn. Especially vaccinations in summer and autumn could be crucial for transfer of high maternal antibody titres to the offspring.
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Keywords: Classical swine fever; Wild boar; Oral vaccination; Maternal antibodies

1. Introduction

Classical swine fever (CSF) is a highly contagious and often fatal viral disease in domestic pigs and wild boar. In countries with an intensive pig production and a high wild boar density, CSF can have a serious impact on agriculture and forestry. As a result of CSF outbreaks in Europe during the 1997/1998 epidemic approximately 10 million domestic pigs were killed. The calculated direct and indirect losses caused by this epidemic amounted to 2.2 billion € (Terpstra and de Smit, 2000), not considering the economic losses in forestry caused by CSF in wild boar.

In Germany, CSF has been present in the wild boar populations of different federal states for several decades. From 4.7% to more than 60% of all CSF outbreaks in domestic pigs in Germany can be attributed to infected wild boar (Pittler et al., 1995; Fritzemeier et al., 1998; Schlüter and Kramer, 2001). To accelerate CSF eradication in wild boar, oral immunisation has been introduced as a control measure starting with the first field trial in 1993

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(Kaden et al., 1995, 2000). In the meantime, it has proved to be a successful tool for CSF eradication in several federal states of Germany (Kaden et al., 2002). In accordance with Council Directive 2001/89/EC (Anonymous, 2001) it is now permitted to immunise wild boar against CSF. Although a practicable oral immunisation procedure against CSF has been developed, vaccination of young wild boar has not been as effective as in older animals as observed during the first field trials in Germany (Kaden et al., 1995, 2000, 2002; Kern and Lahrmann, 2000). Several factors may have resulted in an only low seroprevalence rate in young boars (Kaden et al., 2000, 2002). Even if neutralising maternal antibodies might interfere with the immune response to vaccination with the C-strain virus, these antibodies are important for protection from CSFV infection in wild boar piglets during the first weeks of their life.

Therefore, we studied the development of maternal antibodies in the blood of wild boar piglets born by young female wild boar vaccinated at different points in time before farrowing.

2. Materials and methods

2.1. Vaccine

A conventional C-strain live virus vaccine was used for oral immunisation as described by Kaden et al. (2001). The vaccine dose contained $10^{6.0}$ PD_{50}.

2.2. Animals and housing

Three-eight to 14 months old female wild boar were used in this study. The sows had been raised in a zoo in Mecklenburg-Western Pomerania or were derived from our own breeding unit. The animals were kept conventionally in free range husbandry. Prior to the experiment the sows were tested negative for antibodies to pestiviruses.

2.3. Experimental design

The wild sows were vaccinated orally with the content of one vaccine dose (1.6–1.8 ml) by means of a syringe. One young female wild boar (s1), vaccinated once at the age of 8 months, was covered naturally about 9 months later and farrowed three normally developed piglets after the normal gestation period. A 14 months old female sub-adult (s2) was vaccinated twice at an interval of 73 days. Four months after the second vaccination it also was covered naturally and had four healthy piglets. The third female wild boar (s3) born in March 2000 was immunised once in January 2001. It was covered naturally in November 2002, and five healthy piglets were born in February 2003. Further data of the experimental design are summarised in Table 1.

At different times after birth (see Table 2) the piglets and their mothers were investigated for antibodies to CSF virus (CSFV).

2.4. Detection of antibodies

Sera of the piglets and the mothers were tested for antibodies to CSFV post natum (pn/piglets) and post vaccinationem (pv/sows) by means of the virus neutralisation test (VNT) as indirect neutralising peroxidase-linked antibody assay (Kaden et al., 2001) using the C-strain virus as antigen.

3. Results and discussion

This study reports on the development of maternal antibodies after oral vaccination of young wild boar with C-strain vaccine at different times prior to

Table 1
Summarised data of the experimental design

Parameter	Sow 1 (s1)	Sow 2 (s2)	Sow 3 (s3)
Age of sows at vaccination	8 months	14 months	10 months
Vaccine dose per application	1	1	1
Number of vaccinations	Once	Twice	Once
Interval between vaccination and farrowing	13 months	20 months	26 months

Table 2
Development of neutralising serum antibody titres in piglets and sows

Days	Neutralising titres (ND_{50})														
pn	Sow 1 – piglets				Sow 2 – piglets					Sow 3 – piglets					
	s1	p1	p2	p3	s2	p1	p2	p3	p4	s3	p1	p2	p3	p4	p5
−91					3013										
−82										1024					
−37	512														
4/5	181	1024	1024	1446	1199	1594	2251	1128	2251	723	723	1446	1446	1445	723
18	nd	723	723	512							nd	nd	nd	nd	nd
32/33	256	362	362	256	1510	566	798	515	849		256	512	512	723	256
66/69	nd	16	11	32	nd	213	95	76	∅		45	64	45	45	90
83	nd	16	11	23							nd	nd	nd	nd	nd
94/96	nd	11	11	∅	nd	32	32	16			nd	nd	nd	nd	nd
122/126	256	neg	neg							723	neg	neg	neg	neg	11
150					3013	neg	neg	neg							

Comments: ∅: died intercurrently; nd: not done.

farrowing. As expected, all three animals were serologically positive before birth of their piglets (Table 2). Animal s2 immunised twice at the age of 14 and 4 months before being covered showed the highest neutralising serum antibody titre (1/3013), whereas the two sows vaccinated once at the age of 8 or 10 months had lower antibody titres (1/512 and 1/1024). In principle, the neutralising antibody titres remained constant in all sows over the investigation period. However, a short time after farrowing a slight decrease of the antibody titres was detectable probably traced back to the transfer of maternal antibodies.

For organisational reasons, the piglets could not be investigated on the day of birth. A short time later (on days 4 or 5 pn) all piglets showed high maternal antibody titres depending on the antibody levels of their mothers. Evaluation of the maternal antibodies showed that in all piglets the titre already decreased a short time after birth, independently of the level of neutralising antibodies of the mother. As shown in our study, the higher the neutralising antibody titres in the vaccinated mother were the higher was also the level of maternal antibodies in the offspring. The highest serum antibody titres were induced in sow 2 (1/3013, 91 d anti partum) whose piglets also showed the highest maternal antibody titres (on average 1/1806 ± 548, detected 4 days after birth). The piglets of animals 1 and 3 had lower mean antibody titres 5 dpn (sow 1 1/1165 ± 243, sow 3 (1/1157 ± 373). These results correspond with the experiences of Depner et al. (2000). On day 66 or 69 pn the highest maternal antibody titres were established in the offspring of sow 2 (on average 1/128 ± 74). At the same time the piglets of the other two sows had a mean antibody titre of only 1/20 ± 11 (sow 1) or 1/58 ± 20 (sow 3), respectively. In our study, maternal antibodies were present at a low level until day 94 or 96 after birth. The persistence of maternal antibodies until day 90 pn in domestic piglets after parenteral immunisation of sows was also demonstrated by Launais et al. (1978). Using the C-strain virus, which is contained in our vaccine for oral immunisation of wild boar, Tesmer et al. (1973) found a distinct decrease of the maternal antibodies in the blood of piglets between days 30 and 40 after birth. Terpstra (1977) reported a half life of the maternal antibodies in domestic piglets of about 2 weeks. This result corresponds with our first experiences (Kaden et al., 1999) and with the experiences of Depner et al. (2000) after immunisation of one wild sow.

Our results demonstrate that – independent of the mother's immune status – maternal antibodies do not seem to be present in the offspring of sows vaccinated orally with C-strain vaccine for more than 3 months. However, based on the experiences of Terpstra and Wensvoort (1988) that neutralising antibody titres ≥1/64 protect from CSFV infection we assume that the piglets of wild sows vaccinated twice or immunised a long time before conception have protective maternal antibody titres for about 2 months after birth. This assumption corresponds with the results of Terpstra (1977) that piglets of sows vaccinated parenterally

with C-strain virus are protected from CSFV infection for 5–6 weeks. Based on these experiences and our experimental results we assume that an active immunisation of young piglets from wild sows vaccinated repeatedly or a long time before farrowing is not effective before the third month of their life. Probably, young wild sows vaccinated orally once will induce maternal antibodies that are likely to protect from CSFV infection for only 1 month. Therefore, the offspring of young sows vaccinated following this procedure should be susceptible to CSFV already shortly after birth.

Since the immune status of piglets and their protection during the first weeks of their life depend on their mother's level of neutralising antibodies, a high herd immunity in the wild sow population is required. Based on our study it can be assumed that in piglets of mothers with a high neutralising antibody level protection from CSFV infection is more effective and lasts longer than in piglets from mothers with low antibody titres. To guarantee an effective and relatively long maternal antibody protection of wild boar piglets from CSFV, wild sows should be vaccinated repeatedly, and the oral vaccination should take place a relatively long time before birth of the offspring. The latter is corroborated by the investigations of Corthier and Charley (1977). These authors detected that the avidity of maternal antibodies after vaccination of domestic pigs against CSF depends on the time the vaccination takes place before farrowing. Maternal antibodies of sows vaccinated >5 months before birth of their piglets showed a higher avidity than antibodies derived from sows immunised shortly before farrowing.

The presently applied vaccination program based on the C-strain vaccine consists of three campaigns of double vaccination per year. Especially the oral immunisation campaigns in summer and autumn should be effective not only for immunisation of wild sows with regard to the development of high levels of maternal antibodies but also for vaccination of young boars (Kaden et al., 2003).

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