Polish Journal of Veterinary Sciences Vol. 15, No. 1 (2012), 37-42

DOI 10.2478/v10181-011-0111-y

Original article

Influence of long-term vaccination of a breeding herd of pigs against PCV2 on reproductive parameters

Z. Pejsak[1], G. Kusior[2], M. Pomorska-Mól[1], K. Podgórska[1]

[1] Department of Swine Diseases, National Veterinary Research Institute, Al. Partyzantów 57, 24-100 Puławy, Poland
[2] Chot-Tucz, Chotycze, Poland

Abstract

The objective of the study was to evaluate an efficacy of sows vaccination protocols in the herd with serious problems affecting efficacy of reproduction. The study was performed in a large pig herd with about 1200 sows. Before vaccination against PCV2, farrowing rate in this farm was about 65%.

Sows, boar and replacement gilts were immunized using Circovac vaccine (Merial, France) according to producer's recommendations. Parameters of production were analyzed since 2007 until 2010 in selected batches of sows inseminated at the same weeks of the year (17th, 18th, 19th and 20th) to eliminate seasonal variability. In total, 940 sows were subjected to the study. No significant changes in management during these years were introduced.

The applied protocol of sow herd long-term vaccination proved to be very efficient. All measured production parameters: reproduction rate, number of piglets born alive, birth weight of piglets and number of piglets weaned per a litter improved after implementation of immunization program. Moreover, further improvement was observed with vaccination in the following reproduction cycles. The most spectacular effect of vaccination regarded average farrowing rate that increased from 64.76% in control group to 86.93% after basic vaccination. Two years after implementation of vaccination program this parameter reached 93.6%. Number of piglets weaned per sow per a litter improved from 10.31 to 11.74 after one year of vaccination and remained relatively stable through the following year. Simultaneously, the percentage of newborn piglets with birth weight < 1 kg decreased significantly ($p < 0.05$).

To summarize, vaccination against PCV2 influenced positively the insemination rate, number of piglets born alive and weaned per litter as well as birth body weight and percentage of piglets weighing < 1 kg.

Key words: reproduction, sow, PCV2, vaccination

Correspondence to: Z. Pejsak, e-mail: zpejsak@piwet.pulawy.pl, tel.: +48 81 889 30 30

Introduction

Porcine circovirus type 2 (PCV2) is involved in the pathogenesis of several economically important diseases including Post-Weaning Multisystemic Wasting Syndrome (PMWS), PCV2-associated granulomatous enteritis, Porcine Respiratory Disease Complex (PRDC), Porcine Necrotizing Pneumonia (PNP), necrotic enteritis, piglets congenital tremor and PCV2-associated porcine reproductive disorders (PCV2-PRD). Whether Porcine Dermatitis-Nephropathy Syndrome (PDNS) is actually primarily caused by PCV2 has not yet been unequivocally proved. To stress the role of PCV2 in these syndromes a new expression Porcine Circovirus (Associated) Diseases (PCVD or PCVAD) is currently used (Opriessnig et al. 2007).

Diagnostic of PCVD is complicated by common subclinical PCV2 infections. Serological studies revealed that nearly 100% of swine herds in Europe, the USA, and Canada are positive for specific PCV2 antibodies (Opriessnig et al. 2007). Before 2005 PCVD-related losses were limited mainly with the help of management measures. The prophylactic use of high quality sera from convalescent animals gave inconsistent results (Baker et al. 2009). Currently, several PCV2 vaccines designed for immunization of sows or piglets have been registered. Several studies proved that all vaccines give very good results with respect to limiting losses due to PCVD (Kixmoller et al. 2008, Fort et al. 2009, Opriessnig et al. 2009). In herds where losses associated to PCVD affect mainly growers and finishers vaccination of piglets should be applied (Cline et al. 2008, Horlen et al. 2008, Pejsak et al. 2010). Additionally, ear necrosis reduction was reported in pigs after vaccination against PCV2 (Pejsak et al. 2011). It was also proved that infections with PCV2 may have a negative effect on reproduction (Bogdan et al. 2001, Ladekær-Mikkelsen et al. 2001) and in this context it would be beneficial to immunize pregnant sows (Joisel et al. 2008).

The objective of the present study was to investigate the effect of long-term vaccination of sows against PCV2 on reproduction performance in a farm with significant reproductive problems.

Materials and Methods

Farm description

The study was carried out in a farrow-to-finish operation suffering from unexpected low reproductive efficacy of unexplained background. A reproductive herd consisted of 1200 hybrid sows and 10 boars. Strict "all in/all out" procedure was maintained in the farrowing, nursery and fattening units. The farm operated in a one week production cycle. Every week a batch of about 50 pregnant sows (10 days before farrowing) was introduced into a farrowing house. Piglets were weaned about 28 day of life and then moved to nursery units.

All gilts and sows were vaccinated against parvovirus (PPV) three weeks before artificial insemination (AI). Boars were vaccinated against PPV, PCV2 and erysipelas every 6 months. The following pathogens were detected in a breeding herd during the study: *Pasteurella multocida, Haemophilus parasuis, Streptococcus suis* type 2 and PCV2. The herd was free from PRRSV (serologically – ELISA and virologically – PCR), Aujeszky's disease virus (serologically – ELISA), *Leptospira* spp (serologically – microscopic agglutination test (MAT) and *Brucella suis* (serologically – Rose Bengal Test (RBT). In this farm sporadic clinical cases of PMWS among weaners were observed, which were in favour of the involvement of PCV2.

Procedure

Breeding herd was immunized using Circovac (Merial, France), an oil- adjuvanted vaccine containing inactivated PCV2. First time sows were immunized twice, 6 and 3 weeks before farrowing. The booster vaccination in the following reproductive cycles was administered about 3 weeks before every farrowing. The replacement was internal and gilts were given the second dose of the vaccine during acclimatization and then followed a basic vaccination program.

Efficacy of insemination was evaluated based on ultrasound test and percentage of effective farrowings. Other parameters including number of piglets born alive/dead per litter, average piglets birth weight, percentage of piglets with the birth weight < 1 kg, average number of piglets weaned per litter and mean number of piglets weaned yearly per sow were analyzed. Production parameters were collected using AgroSoft computer program (AgroSoft North America Inc, USA).

In total 940 sows were subjected to the study. Two hundred and eighty one non- vaccinated sows inseminated 17th, 18th, 19th and 20th week of 2007 served as a control group. One hundred and seventy six sows inseminated during the same weeks of 2008 year were vaccinated twice – in a basic vaccination in July/August 2008. Corresponding batches in 2009 and 2010 consisted of 233 and 250 sows respectively, were vaccinated in every production cycle starting from year 2008. In every group approximately 20%

Table 1. Detail concerning management of reproduction before and during vaccination against PCV2.

Parameter	Before vaccination	During vaccination
Female Genetic	PIC genetic Line Comborough 22 and 26	
Male Genetic	Duroc	
Management of gilt self replacement	Introduction to breeding at 5 months of life and body weight gain over 100 kg; first insemination in 3rd oestrus (body weight gain 135 kg)	
Replacement rate/% of 1st parity	38%/20%	37%/19%
Boar management	Ten boars were used yearly. Three out of ten boars were replaced every year. The semen was taken once for a week. Boars were vaccinated against PPV, PCV2 and erysipelas every 6 months	
Sow batch management	See section 2.1	
Average parity	3.35	3.41
Estrus detection /synchronisation	Boar exposure/no	
Semen preparation	Semen were diluted in BTS or Chronos (MEDINOVA)	
AI technique	Gilts and sows were inseminated on the day when oestrus was detected and again (once or twice) with 12-18 h interval	
Ultra sound pregnancy monitoring	26-28 days after AI	
Farrowing synchronization	Yes, Bioestrovet (Vetoquinol)	
Cross fostering rules	Concern about 17-20% piglets	
Weaning	All piglets are weaned at 28 days of life	
Data recording	AgroSoft computer program, USA	
Personal dedicated to reproduction management	three persons (specially trained) were dedicated to reproduction management (the same persons during observation period)	
Feeding programme (gilts)	Standard commercial diet. The same during observation period	
Feeding programme (sows)	Standard commercial diet. The same during observation period	
Feeding programme (sucking piglets)	From 5 days of age, piglets were allowed access to a commercial pre-starter feed	

of inseminated females were primiparous. No significant changes in management during these years were introduced (Table 1).

Statistical analysis

Data from all groups were subjected to the W. Shapiro-Wilk's test of normality and the Levene'a test of equal variances. In the case of a lack of normality or different variances, measured parameters were tested with a nonparametric Kruskal-Wallis test with post hoc multiple comparisons for comparison of all pairs. In the case of normal distribution and equal variances, the one-way ANOVA with HSD Tukey's *post-hoc* test were used. Differences with $\alpha < 0.05$ were considered as significant. All calculations were performed with the Statistica 8.0 (Statsoft, Poland) computer program.

Results

After implementation of vaccination against PCV2 improvement of all reproductive parameters was observed (Table 2, 3 and Fig. 1). Gradual increase of efficacy of insemination (expressed as a farrowing rate) was observed in the following years of the study. After the first vaccination cycle, this parameter significantly increased from 64.76% to almost 87% (ANOVA, $p = 0.0002$). In the next years after implementation of vaccination the efficacy of insemination reached 89.69% after the first year of vaccination and 93.6% after the second year of vaccination. There were no significant differences regarding efficacy of insemination between groups of sows vaccinated in consecutive years (ANOVA, $p \geq 0.05$), however slightly positive tendency was observed.

Table 2. Summary of insemination efficacy based on farrowing results (IEF).

Sows group	Number of sows inseminated	Number of sows farrowing	Change (%) in IEF in comparison to the group before vaccination
Non-vaccinated	281	182	–
After 1st cycle of vaccination	176	153	+ 34.23%
After 1 year of vaccination	233	209	+ 38.49%
After 2 years of vaccination	250	234	+ 44.53%

Table 3. Summary of farrowing and weaning rates in groups of sows non-vaccinated and vaccinated against PCV2 (mean ± SD)

Sows group	Number of piglets born per litter		Birth weight (kg)	Percentage of piglets weighing < 1 kg	Number of piglets weaned per litter
	alive	dead			
Non-vaccinated	11.22 ± 0.34^{a}	0.62 ± 0.12	1.25 ± 0.01^{a}	8.67 ± 3.53^{a}	10.31 ± 0.11^{a}
After 1st cycle of vaccination	11.87 ± 0.33^{b}	0.47 ± 0.05	1.37 ± 0.02^{b}	2.84 ± 0.88^{b}	10.82 ± 0.24^{a}
After 1 year of vaccination	12.90 ± 0.18^{c}	0.42 ± 0.09	1.46 ± 0.01^{c}	2.83 ± 1.10^{b}	11.74 ± 0.44^{b}
After 2 years of vaccination	12.82 ± 0.20^{c}	0.45 ± 0.1	1.35 ± 0.02^{b}	4.85 ± 1.94^{a}	11.60 ± 0.19^{b}

a,b,c – significant differences within column (p<0.05)

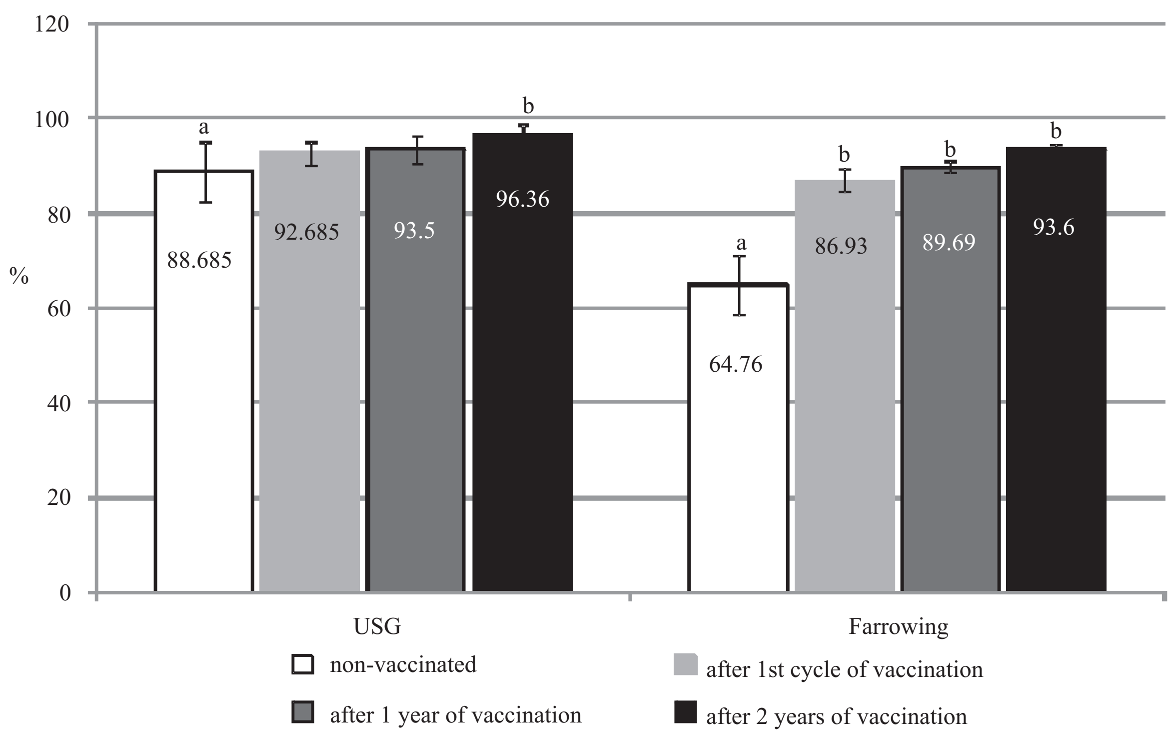

Fig. 1. Insemination results based on ultrasonography and farrowings in non-vaccinated sows and in sows vaccinated against PCV2.
a,b – significant differences (p<0.05)

After the first vaccination cycle sows had significantly higher number of piglets born alive compared to non-vaccinated ones (ANOVA, $p = 0.0153$). Significant differences were observed also between number of piglets born alive by females vaccinated for one and two years in comparison to non-vaccinated sows (ANOVA, $p = 0.0002$). Females vaccinated for one year or two consecutive years had at least 1.6 piglets born alive more per litter, than sows from control group. There were no significant differences between mean numbers of piglets born dead before and after implementation of vaccination program (Kruskal – Wallis, $p \geq 0.05$). However, mean number of piglets weaned per a litter increased significantly from 10.31 in non-vaccinated sows to 11.74 after first year of vaccination ($p = 0.0002$) and to 11.60 in sows vaccinated for two years ($p = 0.0003$). Thus, the mean number of weaned piglets per mated sow increased no less than 1.23 in females vaccinated for one or two years.

The mean birth weight of piglets born to non-immunized sows was significantly lower compared to those observed in piglets born to vaccinated sows (ANOVA, $p = 0.0002$, 0.0001 and 0.0003 respectively for females after 1st vaccination cycle, after one and two consecutive years). The maximal mean birth weight was observed in piglets born to sows vaccinated for one year and it reached over 210 g per animal more than in piglets born to non-vaccinated females. Consequently, decrease of mean number of piglets born with low birth weight (< 1 kg) was observed. The mean proportion of piglets with low birth weight per litter was significantly higher in non-vaccinated sows and reached 8.67%. After 1st vaccination cycle the proportion of piglets born with low birth weight was significantly lower than before vaccination (ANOVA, $p = 0.0107$). After following year of vaccination this difference was also significant in comparison to non-vaccinated sows and reached 2.83% (ANOVA, $p = 0.0105$). However, in the year 2010, it means two years after implementation of vaccination program, the mean percentage of piglets born with low body weight per sow increased and did not differ significantly from that observed in non-vaccinated sows (ANOVA, $p \geq 0.05$).

During whole period of the study, the mean number of piglets weaned yearly per sow increased from 23.71 before implementation of vaccination to 27 and 26.52 one or two years later respectively. Above values were calculated on the basis of number of reproduction cycles per year (average 2.3).

Discussion

The cause of reproduction disorders in analyzed herd was not clearly recognized. However, significant improvement of reproductive parameters after vaccination against PCV2 indirectly suggests that infections with PCV2 could be involved. Previous experimental study proved that PCV2 can be vertically transmitted from viremic sows and infect foetuses causing abortions and premature farrowing (Park et al. 2005). However, in the field conditions reproductive disorders associated with PCV2 are relatively rarely diagnosed. Most of clinical reports concerned newly established farms or introduction of nadve replacement gilts to a breeding herd where PCV2 circulated. Reproductive failure was manifested with increased rate of abortions, mummified, weak or nonviable piglets (O'Connor et al. 2001, Pittman 2008). In the present study about 20% of each inseminated batch of sows were substitute with gilts originating from internal source. Considering that most of the pigs at reproductive age have already been in contact with PCV2 infection, the probability that gilts introduced to the breeding herd were nadve was very low. Nevertheless some reports indicate that subclinical infections with PCV2 may also have an impact on productivity of the herd (Pejsak et al. 2009). In a case of a control study performed in Denmark parameters of production were compared between 74 PMWS-affected and 74 matched control herds. Although reproductive parameters did not differ significantly between these two groups, most of them, including return to oestrus, farrowing rate, number of piglets born alive/litter reached lower levels in PMWS-affected herds (Nielsen et al. 2008). The results of the present study suggest that the influence of PCV2 on reproduction might be underestimated. Moreover, in the present study positive tendency regarding most of reproduction parameters was observed also during subsequent reproduction cycles, even one or two years after implementation of vaccination program. No significant changes in the management during these years were introduced and selection of batches that were included in the analysis eliminated seasonal variability. Therefore, improvement observed after vaccination may be a result of reduction of PCV2 circulation in the herd and infectious pressure. Reduction of PMWS cases observed in the study confirms this hypothesis (data not shown). However, in the year 2010, it means two years after implementation of vaccination program, the mean percentage of piglets born with low body weight per sow increased and did not differ significantly from that observed in non-vaccinated sows (ANOVA, $p \geq 0.05$). Observations in the field linked this situation with exceptionally high temperatures during summer in 2010 that negatively influenced the health of pregnant sows.

In the present study, the most striking improvement concerned the efficacy of insemination which increased from 64.76 to 93.6%. Simultaneously, the number of weaned piglets per litter increased from 10.3 to 11.5. Considering that the number of dead piglets remained at a similar level, this improvement most probably was a result of a reduction of returns to oestrus. Previous experimental studies indicated that infection of embryos with PCV2 before 21st day of gestation may lead to embryonic death and pregnancy loss (Pejsak et al. 2010). Authors reported that in 3 out of 5 sows that received PCV2-exposed embryos a regular return to oestrus was observed. The possibility of infection of embryos with PCV2 in the field conditions has not been investigated. However, intra-uterine infection and spread via semen contaminated with PCV2 was experimentally proved (Madson et al. 2009). Other study demonstrated the presence of PCV2 in reproductive tract in 43 of 55 gilts, despite all of investigated pigs were seropositive (Bielanski et al. 2004).

The results presented in this study confirm the reports on positive impact of sow vaccination on reproductive efficacy, number and weight as well as vitality of newborn piglets. The improvement of reproductive parameters observed after vaccination could be related to immunologic stabilization of the reproductive herd and limiting of PCV2 circulation in immunized pig population. However, it cannot be excluded that other, non-detected in the present study factors, may have influenced obtained results. The economical analysis of expenses against the direct profit showed that every 4 PLN invested in vaccination gave reimbursement of 12 PLN.

References

Baker RB, Madson DM, Patterson AR, Opriessnig T (**2009**) Evaluation of the safety of four porcine circovirus type 2 tissue homogenate vaccines in a pig bioassay. Vet Rec 165: 262-265.

Bielanski A, Larochelle R, Algire J, Magar R (**2004**) Distribution of PCV-2 DNA in the reproductive tract, oocytes and embryos of PCV-2 antibody-positive pigs. Vet Rec 155: 597-598.

Bogdan J, West K, Clark E, Konoby C, Haines D, Allan G, McNeilly F, Meehan B, Krakowka S, Ellis JA (**2001**) Association of porcine circovirus 2 with reproductive failure in pigs: a retrospective study, 1995-1998. Can Vet J 42: 548-550.

Cline G, Wilt V, Diaz E, Edler R (**2008**) Efficacy of immunising pigs against porcine circovirus type 2 at three or six weeks of age. Vet Rec 163: 737-740.

Fort M, Sibila M, Pérez-Martín E, Nofrarías M, Mateu E, Segalés J (**2009**) One dose of a porcine circovirus 2 (PCV2) sub-unit vaccine administered to 3-week-old conventional piglets elicits cell-mediated immunity and significantly reduces PCV2 viremia in an experimental model. Vaccine 27: 4031-4037.

Horlen KP, Dritz SS, Nietfeld JC, Henry SC, Hesse RA, Oberst R, Hays M, Anderson J, Rowland RR (**2008**) A field evaluation of mortality rate and growth performance in pigs vaccinated against porcine circovirus type 2. J Am Vet Med Assoc 232: 906-912.

Joisel F, Charreyre C, Coulombe L, Noel JC, Longo S (**2008**) Vaccination of Sows and Gilts against PCV2 Diseases: Field Experiences in Europe. Adv Pork Prod 19: 183-195.

Kixmöller M, Ritzmann M, Eddicks M, Saalmüller A, Elbers K, Fachinger V (**2008**) Reduction of PMWS-associated clinical signs and co-infections by vaccination against PCV2. Vaccine 26: 3443-3451.

Ladekjćr-Mikkelsen AS, Nielsen J, Storgaard T, Botner A, Allan G, McNeilly F (**2001**) Transplacental infection with PCV-2 associated with reproductive failure in a gilt. Vet Rec 148: 759-760.

Opriessnig T, Meng XJ, Halbur PG (**2007**) Porcine Circovirus Type 2 associated disease: Update on current terminology, clinical manifestations, pathogenesis, diagnosis, and intervention strategies. J Vet Diagn Invest 19: 591-615.

Madson DM, Patterson AR, Ramamoorthy S, Pal N, Meng XJ, Opriessnig T (**2009**) Reproductive failure experimentally induced in sows via artificial insemination with semen spiked with porcine Circovirus Type 2. Vet Pathol 46: 707-716.

Nielsen EO, Enøe C, Jorsal SE, Barfod K, Svensmark B, Bille-Hansen V, Vigre H, Brtner A, Baekbo P (**2008**) Postweaning multisystemic wasting syndrome in Danish pig herds: productivity, clinical signs and pathology. Vet Rec 162: 505-508.

O'Connor B, Gauvreau H, West K, Bogdan J, Ayroud M, Clark EG, Konoby C, Allan G, Ellis JA (**2001**) Multiple porcine circovirus 2-associated abortions and reproductive failure in a multisite swine production unit. Can Vet J 42: 551-553.

Opriessnig T, Patterson AR, Madson DM, Pal N, Halbur PG (**2009**) Comparison of efficacy of commercial one dose and two dose PCV2 vaccines using a mixed PRRSV-PCV2-SIV clinical infection model 2-3-months post vaccination. Vaccine 27: 1002-1007.

Park JS, Kim J, Ha Y, Jung K, Choi C, Lim JK, Kim SH, Chae C (**2005**) Birth abnormalities in pregnant sows infected intranasally with porcine circovirus 2. J Comp Pathol 132: 139-144.

Pejsak Z, Truszczyński M, Porowski M, Podgórska K (**2009**) Effect of porcine circovirus type 2 vaccination of sows on selected production parameters. Bull Vet Inst Pulawy 53: 159-164.

Pejsak Z, Podgórska K, Truszczyński M, Karbowiak P, Stadejek T (**2010**) Efficacy of different protocols of vaccination against porcine circovirus type 2 (PCV2) in a farm affected by postweaning multisystemic wasting syndrome (PMWS). Comp Immunol Microbiol Infect Dis 33: 1-5.

Pejsak Z, Markowska-Daniel I, Pomorska-Mól M, Porowski M, Kołacz R (**2011**) Ear necrosis reduction in pigs after vaccination against PCV2. Res Vet Sci 91: 125-128.

Pittman JS (**2008**) Reproductive failure associated with porcine circovirus type 2 in gilts. J Swine Health Prod 16: 144-148.