

Comparison of intradermal and intramuscular porcine circovirus type 2 vaccination methods concerning labor, production parameters, and antimicrobial treatments: A randomized field study in a Danish finishing herd

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Summary

Vaccination is time consuming and often labor intensive. This study found that porcine circovirus type 2 vaccination of growing pigs could be performed faster using an intradermal, needle-free vaccination method compared to the traditional, intramuscular needle vaccination method without compromising production parameters and antimicrobial treatments.

Keywords: swine, vaccination, intradermal, intramuscular, labor

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Resumen - Comparación de los métodos de vacunación intradérmica e intramuscular contra el circovirus porcino tipo 2 en relación con el trabajo, los parámetros de producción y los tratamientos antimicrobianos: Un estudio aleatorio de campo en un hato de engorde danés

La vacunación requiere mucho tiempo y, a menudo, requiere mucha mano de obra. Este estudio encontró que la vacunación contra el circovirus porcino tipo 2 en cerdos en crecimiento podría realizarse más rápidamente utilizando un método de vacunación intradérmica sin aguja en comparación con el método tradicional de vacunación con aguja intramuscular sin comprometer los parámetros de producción y los tratamientos antimicrobianos.

Résumé - Comparaison des méthodes de vaccination intradermique et intramusculaire contre le circovirus porcine type 2 concernant le travail nécessaire, les paramètres de production et les traitements antimicrobiens: une étude de terrain randomisée dans un troupeau de finition danois

La vaccination demande du temps et est souvent exigeante en termes de travail. La présente étude a déterminé que la vaccination contre le circovirus porcine type 2 de porcs en croissance pourrait être effectuée plus rapidement en utilisant une méthode de vaccination intradermique sans aiguille comparativement à la méthode traditionnelle de vaccination intramusculaire avec une aiguille sans compromettre les paramètres de production et les traitements antimicrobiens.

Vaccination procedures in today's pig production are time consuming and labor intensive. The potential for new inventions in this area therefore warrants consideration. Although the concept of intradermal (ID) vaccination is well-established in veterinary medicine,^{1,2} few practical applications have been developed until recently. In 2013, the first generation of a device (IntraDermal Application of Liquids [IDAL]; Henke Sass Wolf for MSD

Animal Health) allowing needle-free, ID vaccination of pigs became available in Denmark. Only a small volume can be injected ID, therefore this vaccination method requires specially developed vaccines. In 2016, an ID vaccine for protection against porcine circovirus type 2 (PCV2) infection (PORCILIS PCV ID; Intervet International B.V.) was marketed as demonstrating reduced mortality and improved average daily gain (ADG)

compared to unvaccinated pigs.³ Subsequently, the interest for the method has increased.

A couple of studies have demonstrated improved animal welfare by using the needle-free, ID vaccination method compared to the traditional, intramuscular (IM) method using a needle and syringe.^{4,5} Also, farmers' feedback gives the impression that the vaccination procedure duration is shortened

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with the ID method because injection at a specific site is not required (such as behind the ear for the IM method). This impression was supported by one study demonstrating a 6-second shorter procedure per piglet for ID versus IM vaccination methods.⁶ The present study aims to clarify if this advantage of the ID method also exists when vaccinating older pigs for PCV2. Although improved animal welfare and reduced labor costs are important for pig production, the efficacy of the administered vaccine must not be compromised in the pursuit. The study objectives were to compare the duration of ID and IM PCV2 vaccination procedures for growing pigs while monitoring production parameters and antimicrobial treatments in the subsequent growing-finishing period.

Materials and methods

Herd characteristics

All animals were under veterinary oversight and care and feed, water, and environment met the Ministry of Environment and Food of Denmark requirements. Pigs and their environment were monitored daily by caretakers. All feed rations were formulated to meet or exceed normal nutritional recommendations for swine. The genetic line was Landrace-Yorkshire-Duroc with all pigs originating from the same sow herd. The study was conducted from December 2015 to April 2016 in a PCV2-positive Danish finishing herd producing 20,000 pigs per year. Prior to the study, active PCV2 infection was confirmed by a moderate level of viremia (4 to 6 log₁₀ PCV2 copies/mL) analysed by quantitative polymerase chain reaction⁷ at Technical University of Denmark, National Veterinary Institute in Copenhagen. The farm had a total of 8 rooms, each containing 16 double pens with 36 to 38 pigs per pen. A liquid feed system was present with 2 adjacent, single pens sharing a feed chute (a double pen). Feed conversion rate (FCR) was an outcome parameter and so double pen was the statistical unit of the study. For simplicity, the double pen statistical unit is hereafter referred to as pen. During the study, standard farm procedures including all-in, all-out management of rooms, weight- and gender-based sorting of pigs on arrival, and a 3-day treatment with tylvalocin (Aivlosin; Salfarm Danmark A/S) against *Lawsonia intracellularis* starting 5 days after arrival

were maintained. Apart from this initial group treatment, all antimicrobial treatments were given as individual injection treatments.

Study design

The study was conducted over 6 months as a parallel group study and included 8 batches of pigs, each containing 600 pigs weighing approximately 30 kg, arriving 1 week apart. Each batch was allocated to 1 room and sorted by herd personnel to pens based on gender and weight. The following day, pen total start weight was recorded and pens were allocated randomly by dice rolling to ID or IM treatment groups balanced for gender, start weight, and number of pigs per pen to account for potential confounding effects of these variables.

Then, pens of pigs were vaccinated by the ID or IM method according to group allocation. For ID PCV2 vaccination, 0.2 mL of PORCILIS PCV ID (MSD Animal Health) was administered using the IDAL second generation device. For IM PCV2 vaccination, 1 mL of Ingelvac Circo-FLEX (Boehringer Ingelheim Vetmedica GmbH) was administered by needle and automatic syringe (Eco-Matic; Henke Sass Wolf). The same caretaker performed all vaccinations following the same procedure for both methods, one pen at a time. More specifically, all pigs in a pen were restricted to a small area to avoid inexpedient movements during vaccination. Intramuscular vaccination was performed by injecting the vaccine right behind the ear. Intradermal vaccination was performed on the dorsal part of the pig between the neck and the rump. Duration of the vaccination procedure was measured using a stopwatch and comprised the time span between the first and the last pig of the pen being vaccinated and included bottle and needle replacements. For the IM group, routine needle replacement occurred approximately every 20 vaccinations.

During the finishing period, the death or antimicrobial injection treatments of individual pigs were recorded at pen-level by herd personnel daily. Herd personnel also selected pigs for slaughter based on a visual evaluation of live weight (approximately 110 kg). The study period ended when more than 10 pigs in a room had been selected for slaughter, at which point all remaining pigs in the room were weighed pen-wise as a group to obtain a pen total end weight. Pigs selected for slaughter were weighed individually

and their weights subsequently added to the pen total end weight. Similarly, individual weights of pigs that died or were moved to the hospital room during the study were added to pen total end weight. All weights were recorded by herd personnel.

Data collection and analysis

Feed consumption during the study period was obtained from the feed computer and measured as feeding units (FU), where one FU represented 7.38 MJ.⁸ Hence, FCR = total FUs administered to the pen ÷ (pen total end weight - pen total start weight). For each pen, ADG = pen total weight gain ÷ sum of study days for the individual pigs in the pen. For mortality, transfer to hospital room, and sent to slaughter, the sum of occurrences per pen for each variable was calculated from the pen-level records. Similarly, individual pig antimicrobial injection treatments were recorded daily at pen level and the sum of study days any pig in a pen received an injection treatment was calculated resulting in a unit measurement of d/pen for antimicrobial injection treatments.

Depending on normality distribution of the data, comparisons between groups for quantitative variables were made using the Wilcoxon rank sum test (duration of vaccination procedure and days of antimicrobial injection treatments) and Student *t* test (start weight, FCR, and ADG). Comparisons between groups for qualitative variables were made using the Fisher exact test (mortality, transfer to hospital room, and sent to slaughter). The significance level was set at $P = .05$, however, due to 8 comparisons on the same dataset, the significance level was adjusted to $P = .006$ (Bonferroni adjustment). All statistical analyses were performed in R.⁹

Results

The study included 4732 pigs distributed across 128 pens and arrived in eight batches. Table 1 shows the allocation of pigs to the two groups at study start, the number of pigs that died, were transferred to the hospital room, or sent to slaughter during the study. No significant differences between the ID and the IM groups were found for the number of pigs that died, were transferred to the hospital room, or were sent to slaughter due to a faster growth rate compared to their batch counterparts.

Table 1: Group allocation of pigs at study start and results for qualitative outcome variables in a field study comparing ID and IM PCV2 vaccination methods

	ID group	IM group	P value
Total No. of pigs	2363	2369	-
No. of pens	64	64	-
Pigs/pen, mean	36.9	37.0	-
Pen start weight, mean (SD), kg	30.35 (3.90)	30.03 (3.88)	.64*
Mortality, No.	25	26	.99 [†]
No. pigs moved to hospital room	122	113	.58 [†]
No. pigs slaughtered	50	40	.33 [†]

* Student *t* test.

† Fisher exact test.

ID = intradermal; IM = intramuscular; PCV2 = porcine circovirus type 2.

Table 2: Pen-level summary statistics of quantitative outcome variables in a field study comparing ID and IM PCV2 vaccination methods

Quantitative variable	Group	Mean (SD)	Median	Minimum	Maximum	P value
Duration of vaccination procedure, s/pen	ID	188 (48)	196	87	323	< .001*
	IM	225 (30)	224	154	299	
Pen FCR, FU/kg	ID	2.50 (0.10)	2.50	2.24	2.76	.68 [†]
	IM	2.51 (0.12)	2.51	2.28	2.88	
Pen ADG, g	ID	1047 (41)	1042	948	1159	.76 [†]
	IM	1044 (47)	1048	915	1158	
Antimicrobial injection treatments, d/pen	ID	32.6 (17.9)	27.5	5.0	84.0	.42*
	IM	30.1 (17.0)	26.5	1.0	78.0	

* Wilcoxon rank sum test.

† Student *t* test.

ID = intradermal; IM = intramuscular; PCV2 = porcine circovirus type 2; FCR = feed conversion rate; FU = feeding units; ADG = average daily gain.

Quantitative variable results are displayed in Table 2. Only the duration of the vaccination procedure was significantly shorter for the ID group, whereas productivity parameters and days of antimicrobial injection treatments did not differ significantly between the groups.

Discussion

This field study demonstrated that, for growing pigs, vaccination by the ID method using the IDAL device could be performed in less time than by the IM method using needle and automatic syringe without compromising production parameters or days of antimicrobial injection treatments. The mean duration for the ID vaccination procedure was 37 seconds shorter per pen and was likely

due to needle changes and higher freedom of choice regarding the injection site. The time savings at pen level correspond to approximately 1 second/pig, which, for this herd, would be around 10 minutes/batch, 6 hours/year, or kr1.400/year (US \$220/year) based on standard hourly rates for a Danish farmer. Costs of the different methods are also important to consider. In this particular herd, the cost of having an IDAL was \$0.02/pig, which is similar to the cost of automatic syringes and disposable needles (\$0.02 to \$0.04/pig depending on the lifetime of the syringe and the frequency of needle replacement). Other less cost-driven considerations should also be taken into account when selecting vaccine administration method, such as increased

animal welfare and reduced pathogen transfer, which has previously been demonstrated for needleless methods.^{4,5,10}

The statistical analyses were kept at a basic level because the study design controlled for most potential confounders, such as gender, weight, and number of pigs per pen. The potential confounding effect of batch was mitigated by distributing groups evenly in every batch. More advanced statistics, such as mixed models, could be relevant, but results are unlikely to be influenced significantly considering the very high *P* values for most outcomes. As the study was only conducted in one herd, however, the results cannot be considered applicable for the pig population in general. Also, comparison of vaccination methods should

preferably be done with the exact same product administered both ID and IM, respectively. However, that was not possible using commercially available PCV2 vaccines. Finally, although the ID method in this study offered a quicker vaccine administration, care should always be taken to ensure correct application of the vaccine.

Implications

Under the conditions of this study:

- Intradermal vaccination method could reduce vaccine-related labor input.
- Intradermal vaccination method could reduce salary expenses.
- Productivity and antimicrobial use did not differ between ID and IM methods.

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Conflict of interest

Drs Ellegaard and Nielsen are employed by MSD Animal Health Nordics. Dr Korsgaard was the study initiator and all outcome parameters were objectively measured either by an electronic system (time recorder, weights, feed consumption) or performed by herd personnel.

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