

Blood parameter changes in Korean traditional calves and pigs after foot-and-mouth disease vaccination

Chun-Nam Cha¹, Eun-Kee Park², Chang-Yeul Yoo³, Suk Kim⁴, Young Won Yun^{5,*}, Hu-Jang Lee^{4,**}

¹Engineering Research Institute, Department of Industrial Systems Engineering, and ⁴Institute of Animal Medicine, College of Veterinary Medicine, Gyeongsang National University, Jinju 52828, Korea

²Department of Medical Humanities and Social Medicine, College of Medicine, Kosin University, Busan 49267, Korea

³Department of Smart Information Convergence, Gyeongnam Provincial Namhae College, Namhae 52422, Korea

⁵College of Veterinary Medicine and Research Institute of Veterinary Medicine, Chungbuk National University, Cheongju 28644, Korea

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Abstract: This study investigated changes in certain blood parameters in calves and pigs after foot-and-mouth disease (FMD) vaccination. In this study, five calves and five pigs were selected from groups of 10 calves and pigs, respectively, and were vaccinated with an FMD vaccine. The remaining animals formed two non-treatment control groups. Blood samples were collected from all animals on the 1st, 3rd, 5th, and 7th days post-vaccination. In the FMD-vaccinated calves and pigs on day 7 post-vaccination, white blood cell counts, blood urea nitrogen levels, and alanine aminotransferase and aspartate aminotransferase activities were higher than those in the respective controls. The present data suggested that the certain hemato-biochemical parameters on cattle and pigs were meaningfully changed between before and after FMD vaccination.

Keywords: calves, foot-and-mouth disease vaccine, hematologic tests, serum biochemical parameters, swine

Foot-and-mouth disease (FMD) is a severe and highly infectious viral disease of farmed animals such as cattle, sheep, goats and pigs [5]. FMD causes the greatest economic damages because of the contagious and severe character of the disease [7]. The disease has a high morbidity and low mortality and develops vesicles and erosions in the mucosa of the mouth and on the skin between and above the hoofs [6]. FMD virus (FMDV) belongs to the genus *Aphthovirus* of the *Picornaviridae* family which includes seven distinct serological serotypes A, O, Asia 1, C, South African territories (SAT) types 1, 2, and 3 and many (sub)lineages [3, 8].

In Korea, major FMD outbreaks have occurred in 2000, 2002, 2010–2011 and 2014–2015 in livestock such as cattle and pigs [6, 7]. On December 25, 2010, Korean government enforced a nationwide blanket vaccination policy for all-FMDV susceptible ruminants and pigs using FMD type O vaccines, as a maintainable preventive means, and a routine vaccination program is still an effective defensive tool against FMDV infection [7]. Considering FMD outbreaks in neighboring countries, trivalent FMD vaccines (types O, A, and Asia 1) were used for typical vaccinations beginning in September 2011 in Korea [6]. The trivalent FMD vaccine is

made up of inactivated viruses with double oil-based emulsion and includes structural proteins of FMD viruses (FMDVs) (O1 Manisa + A Malaysia + Asia 1 Shamir serotypes) [9]. Despite the powerful effects of multivalent FMD vaccines that reduced the enormous FMD outbreak, the trivalent FMD vaccine in pigs injected with a single dose has several problems including the induction of poor humoral immune response and a short-term duration of immunity compared to that induced by natural FMDV infection [1, 7]. In the process of the vaccination practice, the animals can also get stressed by the act of handling, the injection, or a possible inflammatory reaction, and some adverse effects arisen by the vaccination have been reported [4]. In Korea, a single administration of trivalent FMDV vaccine has been mostly adopted for 8 to 12 week-old pigs due to saving the labor and costs, even though two immunizations of the vaccine are led to long-lasting antibody response [6].

The epidemiology and etiology of FMD have been extensively investigated [2]. However, there are few published reports on the changes of the hemato-biochemical parameters in cattle and pigs after FMD vaccination. Therefore, this study was conducted to elucidate the effect of FMD vaccina-

*Corresponding authors

Tel: +82-55-772-2352, Fax: +82-55-772-2308

E-mails: hujang@gnu.ac.kr (HJ Lee), ywyun@cnu.ac.kr (YW Yun)

Table 1. Hemato-biochemical profiles in Korean native calves after foot-and-mouth disease (FMD) vaccination

Group	Post-vaccination (d)	WBC ($\times 10^3/\mu\text{L}$)	RBC ($\times 10^6/\mu\text{L}$)	Hb (g/dL)	PCV (%)	AST (U/L)	ALT (U/L)	BUN (mg/dL)	Cr (mg/dL)
CON	0	8.71 \pm 0.95	6.62 \pm 0.82	10.45 \pm 1.02	34.79 \pm 1.48	113.2 \pm 5.2	31.81 \pm 1.46	15.48 \pm 1.05	1.57 \pm 0.06
	1	8.64 \pm 1.01	6.58 \pm 0.79	10.49 \pm 1.07	34.82 \pm 1.29	112.8 \pm 5.5	31.78 \pm 1.52	15.51 \pm 1.01	1.55 \pm 0.08
	3	8.68 \pm 0.89	6.55 \pm 0.91	10.51 \pm 1.04	34.74 \pm 1.19	112.5 \pm 4.8	31.75 \pm 1.48	15.55 \pm 1.07	1.52 \pm 0.05
	5	8.65 \pm 0.98	6.59 \pm 0.85	10.48 \pm 0.98	34.77 \pm 1.15	112.7 \pm 4.9	31.80 \pm 1.54	15.59 \pm 1.10	1.53 \pm 0.04
	7	8.69 \pm 0.87	6.57 \pm 0.82	10.45 \pm 0.92	34.75 \pm 1.08	112.6 \pm 5.1	31.78 \pm 1.51	15.57 \pm 1.08	1.54 \pm 0.07
FMD-V	0	8.62 \pm 1.06	6.57 \pm 0.73	10.47 \pm 1.25	34.76 \pm 1.37	112.6 \pm 9.3	31.74 \pm 2.95	15.53 \pm 1.24	1.52 \pm 0.12
	1	12.74 \pm 1.23***	6.17 \pm 0.82	10.51 \pm 1.08	35.49 \pm 3.15	118.4 \pm 10.7	33.17 \pm 2.82	18.47 \pm 1.35*	1.61 \pm 0.12
	3	12.24 \pm 1.18***	6.29 \pm 0.75	10.03 \pm 0.96	34.86 \pm 2.92	124.3 \pm 11.5	37.29 \pm 3.25**	22.12 \pm 2.14**	1.71 \pm 0.13
	5	11.55 \pm 1.15**	6.37 \pm 0.87	9.78 \pm 0.93	35.15 \pm 2.75	130.1 \pm 12.3**	40.61 \pm 3.18***	24.41 \pm 2.25***	1.77 \pm 0.16*
	7	10.98 \pm 1.07*	6.42 \pm 0.91	9.49 \pm 0.97	35.27 \pm 2.81	134.7 \pm 11.9**	43.29 \pm 3.27***	25.89 \pm 2.43***	1.82 \pm 0.15**

CON, non-FMD vaccination; FMD-V, FMD vaccination; WBC, white blood cell; RBC, red blood cell; Hb, hemoglobin; PCV, packed cell volume; AST, aspartate aminotransferase; ALT, alanine aminotransferase; BUN, blood urea nitrogen; Cr, creatinine. * $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$ are significant difference compared with that of CON group on the same day after FMD-vaccination.

tion on certain hematological and serum biochemical parameters in calves and pigs.

Ten 9-month-old Korean traditional calves and 12-week-old pigs [(Duroc \times Yorkshire) \times Landrace] without any history of FMD vaccination were selected and randomly divided into 2 groups of each 5 calves and pigs, respectively. Each of the five calves and pigs remained as a non-treated control (CON), while the other animals (FMD-V) were intramuscularly injected with 2 mL of an inactivated FMDV vaccine (PRO-VAC FMD; Komipharm International, Korea). This vaccine was formulated a double oil-based emulsion adjuvant with at least six 50% protective doses (PD₅₀) of the inactivated trivalent FMDVs (O1 Manisa + A Malaysia + Asia 1 Shamir serotypes). All animals were then provided with typical diets and water during the experiment.

Approximately 8 mL of blood was collected into a heparinized vacutainer tube from the tail vein of calves and jugular vein of pigs before FMD vaccination and on 1, 3, 5 and 7 days after FMD vaccination. The collected blood samples were spontaneously transported on ice to the laboratory. White blood cell (WBC) count, red blood cell (RBC) count, packed cell volume (PCV) and hemoglobin (Hb) were analyzed in sampled whole blood using an ADVIA 120 Hematology Analyzer (Bayer, USA). After blood samples were centrifuged (2,000 \times g, 10 min) to separate the serum, alanine aminotransferase (ALT) and aspartate aminotransferase (AST) activities, blood urea nitrogen (BUN) and creatinine concentrations were determined in the serum using a Hitachi 911 Chemistry Analyzer (Roche Diagnostics Korea, Korea). All animal experiments were conducted under ethics approval (GNU-160826-M0058) from the Gyeongsang National University Animal Ethics Committee in accordance with the guidelines of the Korean Council on Animal Care.

Data are expressed as mean \pm SD. Statistical analyses were performed using SPSS version 15.0 (SPSS, USA), including the analysis of variance and Student's *t*-test. The value of $p <$

0.05 was considered statistically significant.

Changes of hemato-biochemical parameters in calves were shown at Table 1. In FMD-V, WBC counts on days 1, 3 ($p < 0.001$), 5 ($p < 0.01$), and 7 ($p < 0.05$) post-FMD vaccination were significantly increased compared to those in CON. However, other hematological parameters were no considerable difference between CON and FMD-V. In serum biochemical parameters of FMD-V, creatinine (day 5, $p < 0.05$; day 7, $p < 0.01$) concentrations, AST (days 5 and 7, $p < 0.01$), ALT (day 3, $p < 0.01$; days 5 and 7, $p < 0.001$) and BUN (day 1, $p < 0.05$; day 3, $p < 0.01$; days 5 and 7, $p < 0.001$) activities were meaningfully different compared to those of CON. Changes of hemato-biochemical parameters in pigs were shown at Table 2. In FMD-V, WBC counts (days 1, 3, 5 and 7, $p < 0.001$) and hemoglobin concentrations (day 1, $p < 0.001$; day 3, $p < 0.01$; day 5, $p < 0.05$) were significantly different compared to those in CON. In serum biochemical parameters, AST (day 3, $p < 0.05$; day 5, $p < 0.01$; day 7, $p < 0.001$), ALT (day 1, $p < 0.05$; day 3, $p < 0.01$; days 5 and 7, $p < 0.001$) and BUN (days 1 and 3, $p < 0.05$; days 5 and 7, $p < 0.001$) activities in FMD-V were significantly different compared to those in CON.

In a previous study on cattle vaccinated with the hexavalent FMD vaccine [10], BUN concentrations, neutrophil and lymphocyte counts in the vaccinated group were significantly elevated compared with those in the non-vaccinated group at 8 weeks after vaccination ($p < 0.05$). However, there were no significant differences in RBC counts, hemoglobin concentrations, PCV, AST, ALT and creatinine concentrations in both vaccinated and non-vaccinated groups. Additionally, another previous study reported that neutrophil and lymphocyte counts in FMD-vaccinated pigs were significantly elevated compared to those in non-FMD-vaccinated pigs ($p < 0.05$) [11]. Furthermore, a preceding study on Korean native goats reported that WBC counts in FMD-vaccinated group were significantly increased, and hemoglobin was

Table 2. Hemato-biochemical profiles in pigs after FMD vaccination

Group	Post-vaccination (d)	WBC ($\times 10^3/\mu\text{L}$)	RBC ($\times 10^6/\mu\text{L}$)	Hb (g/dL)	PCV (%)	AST (U/L)	ALT (U/L)	BUN (mg/dL)	Cr (mg/dL)
CON	0	7.53 \pm 0.29	5.50 \pm 0.21	12.16 \pm 0.49	35.38 \pm 1.15	61.27 \pm 2.24	39.25 \pm 1.31	13.27 \pm 0.52	1.25 \pm 0.04
	1	7.49 \pm 0.31	5.48 \pm 0.19	12.09 \pm 0.51	35.41 \pm 1.27	61.31 \pm 2.31	38.91 \pm 1.39	13.25 \pm 0.58	1.28 \pm 0.06
	3	7.51 \pm 0.28	5.51 \pm 0.23	12.11 \pm 0.47	35.35 \pm 1.29	61.25 \pm 2.15	39.15 \pm 1.42	13.31 \pm 0.65	1.24 \pm 0.05
	5	7.50 \pm 0.30	5.54 \pm 0.27	12.14 \pm 0.53	35.37 \pm 1.09	61.29 \pm 2.28	39.24 \pm 1.28	13.35 \pm 0.55	1.20 \pm 0.07
	7	7.52 \pm 0.29	5.51 \pm 0.25	12.13 \pm 0.51	35.34 \pm 1.12	61.27 \pm 2.24	39.31 \pm 1.31	13.37 \pm 0.59	1.22 \pm 0.09
FMD-V	0	7.46 \pm 0.52	5.52 \pm 0.48	12.10 \pm 1.17	35.32 \pm 3.61	61.23 \pm 5.49	39.22 \pm 1.76	13.32 \pm 1.25	1.22 \pm 0.11
	1	13.48 \pm 1.23***	5.38 \pm 0.51	9.86 \pm 0.85***	33.52 \pm 2.72	66.51 \pm 5.72	35.25 \pm 2.91*	15.63 \pm 1.69*	1.24 \pm 0.12
	3	18.31 \pm 1.45***	5.52 \pm 0.53	10.42 \pm 1.02**	32.94 \pm 3.14	69.42 \pm 6.01*	32.61 \pm 3.14**	16.35 \pm 1.62*	1.27 \pm 0.10
	5	22.90 \pm 2.83***	5.67 \pm 0.49	10.85 \pm 1.04*	32.52 \pm 3.12	73.81 \pm 6.15**	30.86 \pm 2.82***	17.62 \pm 1.64***	1.29 \pm 0.13
	7	26.74 \pm 2.95***	5.71 \pm 0.52	11.07 \pm 1.15	32.35 \pm 3.15	77.54 \pm 6.21***	29.73 \pm 2.75***	18.87 \pm 1.67***	1.32 \pm 0.17

* $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$ are significant difference compared with that of CON group on the same day after FMD-vaccination.

meaningfully decreased compared to those in non-FMD vaccinated group at 8 h after FMD vaccination ($p < 0.05$) [4]. Based on the increase of WBC count in this study, the FMD vaccination looks like an induction of inflammatory response to calves and pigs. In addition, the elevation in serum AST and BUN may be associated with glucocorticoid excess so stress can elicit a marked increase in serum AST and BUN activity [10]. With the consideration of species and blood sampling times after FMD vaccination, the present findings for changes of hemato-biochemical parameters in cattle and pigs, were comparable to previously published data of hematological and serum biochemical parameters.

In conclusion, the present data suggested that the certain hemato-biochemical parameters on cattle and pigs were meaningfully changed between before and after FMD vaccination. Further study is needed to investigate the change of hematological and serum biochemical parameters for more cattle and pigs over a long period of time.

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