J Vet Clin 29(4) : 315-318 (2012)

Journal of Veterinary Clinics
www.ksvc.or.kr

Infection of Foot and Mouth Disease of Serotype A in Farm-raised Deer in Korea

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(Accepted: July 04, 2012)

Abstract : This report describes a case of foot and mouth disease (FMD) in farm-raised Sika deer. FMD serotype A occurred in six cattle farms in January 2010 since the outbreak of pig cases 2002 in South Korea. In addition to the six cattle farms where the disease occurred during January, positive reactions to FMD antibodies were found in two heads of deer on March at a deer farm in serological tests intended to lift the movement restriction of the susceptible animals imposed within risk zone. In the specimens collected from 12 heads for confirmatory tests in the same farm, no virus was detected in antigen tests and neutralising antibody titers in all raising deer in the farm were relatively high. So it seems likely that the animals had been infected with FMD at least one month earlier when they were found.

Key words **:** Deer, foot and mouth disease, natural infection.

Introduction

From January 2 through 29, 2010, foot and mouth disease (FMD) serotype A occurred in six cattle farms within surveillance zone (10 km radius) from first FMD infected premise (Table 1 and Fig 1). In addition to these farms, surprisingly, there was an evidence of FMD infection in a deer farm around the infected cattle farms. The FMD viruses identified from these infected cattle were classified into an ASIA topotype (gb GU441855), which prevailed in 2008-2009 in East Asia or Southeast Asia (2,6). FMD that has not occurred for eight years in Korea was reintroduced, and epidemiologically, it is suspected that foreign workers who were working in the farms might have transmitted the disease.

Deer are raised in Korea mostly for deer antlers, and Sika deer or elk are the most frequently raised species. Most deer farms raise 10 or fewer deer. The outbreak of FMD in deer was the first one in Korea.

Case

In addition to the six cattle farms where the disease occurred during January, positive reactions to antibodies were found in two heads of deer on March 9 at a deer farm in serological tests intended to lift the movement restriction of the susceptible animals imposed within risk zone (3 km radius) around the last 6th FMD outbreak farms (Fig 1). FMD confirmatory tests were conducted on all twelve deer at the affected farm and only FMD antibodies were detected in all. The clinical symptoms of the affected deer were not reported, so the infection may be considered to be subclincal infection. These animals were culled the next day (Mar 10, 2010) after FMD confirmation. The rapid lateral-flow assay (LFA) for antibody (PBM Co Ltd, USA) were used for simplified diagnoses on

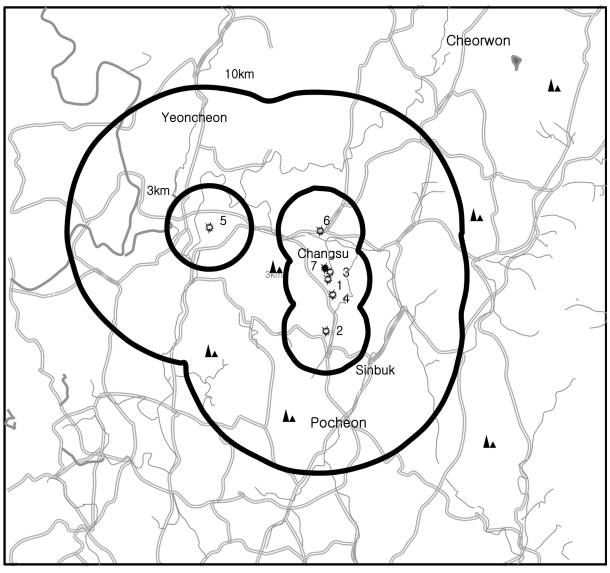

Fig 1. The map of FMD serotype A cases distribution in Pocheon and Yeoncheon area of Gyeonggi-province, Korea in 2010. The Arabic numbers in figure were shown as 1st -7th cases. The 7th outbreak of A type was shown as a black dot.

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Table 1. FMD Serotype A outbreaks in Korea between January and March 2010

Infected premise	Region	Distance from first infected premise	Farm type	No. animals culled	No. of positive	Date reported	Lab. diagnosis	Date culled
A-IP1	Pocheon	-	DC[1]	185	6	2 Jan	7 Jan	8 Jan
A-IP2	Pocheon	3.5 km	H[2]	15	2	13 Jan	13 Jan	13 Jan
A-IP3	Pocheon	0.6 km	DC	56	6	15 Jan	16 Jan	15 Jan
A-IP4	Pocheon	0.9 km	DC	54	2	15 Jan	16 Jan	15 Jan
A-IP5	Yeoncheon	9.3 km	H	34	4	18 Jan	19 Jan	19 Jan
A-IP6	Pocheon	3.8 km	DC	81	9	29 Jan	30 Jan	30 Jan
A-IP7[3]	Pocheon	1.5 km	Deer	12	12	9 Mar	10 Mar	9 Mar

[1]DC : Dairy cattle, [2]H : Hanwoo (Korean native cattle), [3]Antibody positive, Virus undetected.

Table 2. Summary of laboratory diagnostic test results of FMD (A-IP7) in deer in Korea 2010

No. of Deer	Tests for antibody in sera (No. positive/No. tested)					Tests for antigen in OP fluids/tissue	
	NSP ELISA	Rapid test (NSP)	SPC ELISA	LPBE titer	VN titer	RT-PCR (OPF[1]/OPT[2])	Virus isolation (1st/2nd)
1	+	+	+	362	2,896	-/-	-/-
2	+	+	+	362	2,896	-/-	-/-
3	+	+	+	181	1,448	-/-	-/-
4	+	+	+	512	2,048	-/-	-/-
5	+	+	+	1,448	2,896	-/-	-/-
6	+	+	+	1,448	2,896	-/-	-/-
7	+	+	+	362	1,024	-/-	-/-
8	+	+	+	1,448	2,048	-/-	-/-
9	+	+	+	724	2,048	-/-	-/-
10	+	+	+	1,448	2,048	-/n.a[3]	-/-
11	+	+	+	1,448	4,096	-/n.a	-/-
12	+	+	+	1,024	4,096	-/n.a	-/-

[1]OPF : oropharyngeal fluids, [2]OPT : oropharyngeal tissue, [3]n,a : not available.

the spot (Table 2). For antigen tests among laboratory thorough tests, RT-PCR for detecting the nucleic acid of the virus and antigen ELISA for proving FMDV proteins were conducted on tissues and saliva. The RT-PCRs amplifying universal site (IRES) of FMDV for detection of all serotype of the virus and VP1 sites for the differentiation of three serotypes were conducted (4). The ELISA for the infecting antibody NSP(non-structural protein) (5) was conducted, and structural protein (SP) antibody (3) or liquid phase blocking ELISA (LPBE, World Reference Laboratory, UK) for A serotype were conducted as confirmatory tests. The virus neutralisation test using different virus strains (A-Iraq22 and A type isolate in Korea 2010) was tried by following World Organization for Animal Health (OIE) manual.

Both NSP and SP antibodies were detected in all animals (Table 2), and the virus neutralizing titer was highest against the virus isolated during that outbreak among A, O and Asia 1 serotypes (Fig 2). The oro-pharyngeal fluids were collected to conduct antigen tests, and oro-pharyngeal tissues were also examined after culling. No antigen was detected in RT-PCR (Table 2). The deer infected with FMD were at a farm raising 12 deer located within 3 km of the 6th outbreak farm and only 1.6 km away from the 1st outbreak farm where the disease occurred on January 15th. Since the farm was closer to the 1st, 3rd and 4th outbreak farms than to the last 6th outbreak farm, it was assumed that the animals were affected between January 2nd and 15th. Given the facts that no virus was detected in antigen tests and that neutralising antibody titers in all raising deer in the farm were relatively high (1: 1,024~4,096), it seems likely that the animals had been infected at least one month earlier when they were found (Fig 2). After the detection of antibodies from two heads of deer on March 9th, along with the collection of specimens from 12 heads for confirmatory tests, the deer were immediately culled and strong disinfecting actions followed the culling.

Discussion

Though some minor symptoms of FMD was reported in Sika deer (1), it is quite likely that elks would show no

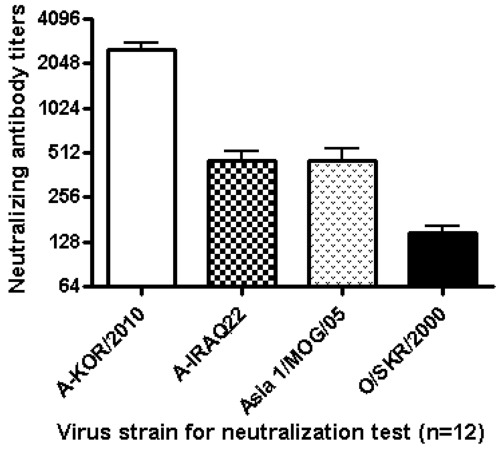

Fig 2. Comparison of antibody titers by VNT of FMDV-A, Asia 1 and O serotype viruses in FMDV-infected deer. The error bars represent standard error means (SEM). The P value by ANOVA was < 0.0001. VNT : virus neutralization test using separate virus strains (A-Iraq22 and A type isolate in Korea 2010) or serotypes (O/SKR/2000 and Asia 1/MOG/05).

symptoms even after experimental contact of infected cattle (8). The farmer did not identify any clinical symptom, such as anorexia, and no trace of healing after infection was identified in findings through postmortem clinical observations either. This fact supports the possibility that the Sika deer produced antibodies to FMDV with asymptomatic infection.

After the detection of antibodies, the deer were immediately culled. Therefore, there was no additional related virus excretion after March 10th. The risk of FMD spreading should have not been high. After additional movement restriction for two weeks, clinical examinations and serological tests were again conducted on the susceptible animals such as cattle and pigs of all 41 farms in the risk zone, and all tested animals were identified as negative untill lifting the movement restriction. This case in deer was considered as a result of FMD spreading from cattle to deer, resulting in additional outbreaks.

It is difficult to find recent outbreaks of FMD in deer throughout the world since there were only a large scale outbreak in the America in 1926 and some outbreaks in deer in a few zoos (7). In this outbreak, natural asymptomatic infections of deer with FMD could be identified. Given that subclinical infection occurred in a deer farm, as in the mild or subclinical case of sheep or goats in regions where FMD occurred, in addition to clinical examinations, it is necessary to conduct serological tests for the detection of FMD infected farms.

Conclusions

FMD serotype A occurred mainly in cattle and deer farms in January 2010, and there was no outbreak in pigs, although there were many cloven-hoofed animal farms in the vicinity. Also, we could not identify any clinical symptom in infected deer. It was supposed that the virus was highly contagious to cattle and deer, and a thorough culling policy and preemptive culling were identified as very useful preventive actions. Therefore, a domestic declaration of FMD freedom on this outbreak could be issued in a relatively short period of 81 days after first outbreak. No vaccination was implemented as the disease occurred in only Gyeonggi province and major infection hosts were identified as cattle and deer, but not pigs. It is thought that there were no additional FMD outbreaks in other provinces because of fast culling of susceptible animals on infected farms and the preemptive culling of animals within a distance of 500 meters of infected and epidemiologically related farms.

Acknowledgements

This work was supported by the Animal, Plant and Fisheries Quarantine and Inspection Agency (QIA), Korea.

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국내 사슴에서 구제역 A형 감염증례

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농림수산검역검사본부

요 약 : 2010년초 국내 구제역 발생에서 사슴에서 구제역 A형 감염 사례를 확인하였다. 2002년 O형 구제역이 돼지에서 발생된 이후에 8년만인 2010년 1월에 처음 소에서 A형 구제역이 발생된 이후 6농가에서 발생하였고, 같은 해 3월 발생농가 주변 이동제한 해제를 위한 사슴 항체검사에서 2마리의 사슴에서 구제역 항체양성을 확인하였다. 추가적으로 동일농장에 사육중인 12두에 대한 추가 검사에서 구제역바이러스는 검출되지 않았으며, 비교적 높은 구제역A형에 대한 중화항체가 검출되었다. 그 이후 구제역 A형에 대한 추가 발생은 없었다.

주요어 : 구제역, 사슴, 자연감염