Potential transmission of foot-and-mouth disease from pigs to cattle in a mixed animal farming

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Received: 11 November 2019; Accepted: 17 March 2020

ABSTRACT

In the present report, investigation of foot-and-mouth disease (FMD) outbreak in a commercial pig farm located in the outskirts of Bengaluru in February 2018 was carried out. Disease with high morbidity and severity was noticed in the pig herd consisting of 500 animals. Clinically, the animals showed marked dullness, off feeding and limping along with severe vesicular lesions and ulcers on snout and skin around the coronary bands of pigs. The outbreak was caused by FMDV type O as tested by sandwich ELISA of the samples collected from a dead piglet. Demonstration of high levels of antibodies to structural proteins specific to serotype O (as compared to two other serotypes) in the presence of high titres of non-structural antibodies in the randomly collected samples 2 weeks after the episode was suggestive of widespread infection on the farm in the absence of zoo-sanitary measures. Disease transmission in the vaccinated cattle was also evidenced as animals housed in close proximity developed the disease. Vaccination of pigs in addition to large animals is important to avoid transmission of the disease to other animals as pigs may serve as source of active infection as observed in the present outbreak.

Keywords: Antigen detection ELISA, Foot and mouth disease, LPB ELISA, NSP antibody ELISA, Outbreak, Pig
February 2018 at a private organized farm and subsequent control measures undertaken. Post-mortem examination of the piglets that died in the outbreak revealed gross lesions typical of FMD, while laboratory investigation for presence of viral antigen in the tissue samples confirmed the disease. Presence of serum antibodies directed towards both structural and non-structural antibodies were demonstrable in the randomly collected samples from the farm at a later stage. The details on disease manifestations, possible causes of outbreak and the risks of disease spread to other farm animals are presented.

MATERIALS AND METHODS

Disease outbreak and clinical manifestations: The outbreak of FMD occurred at a private commercial pig piggery (K G Srikantapur, Bengaluru North, Bengaluru Urban district, latitude 13°03′N longitude 77°47′E). The farmer was not aware of the disease but noticed that the growing pigs in all the sheds had become dull and lame. On close inspection, it was observed that the pigs showed variable degree of lameness and most of the time were recumbent in a huddle at particular place. Squealing due to pain was observed when they were made to move. The pigs were unable to move to the feeders resulting in lower than normal feed intake further leading to loss in the weight gain. Initially, death in piglets was observed and within a week the farmer lost more than 30 piglets due to infection. Two piglets were presented for post mortem and the gross lesions typically were suggestive of FMD. Heart and foot lesions were collected during post mortem and the samples were processed and screened by using serotype detection antigen differentiating ELISA (sandwich-ELISA)

Outbreak investigation: The farm was situated in an isolated area away from the village where about 500 Large White Yorkshire, Duroc and Landrace breeds of different age groups were housed. During the visit it was observed that nearly 300 pigs were affected with the disease. The pigs were fed with kitchen-waste procured from the local restaurants. The food was not boiled before being fed to the animals. The infected animals were not isolated and no disinfection was carried out. Severe vesicular lesions typically on the snout and skin around the coronary bands were observed in the affected pigs. Almost all the affected animals were lame and recumbent due to the severity of lesions. Epithelial surface showed necrosis with prominent raw ulcer on the snout of affected pigs. Severe erosions and ulcerations around the coronary band with sloughing of the claw were also evident in few affected pigs. The farmer also was rearing 12 number of cattle and regularly vaccinated against FMD, but three heifers which had received fewer vaccinations, showed clinical signs first, before the disease spread to other animals with mild clinical signs. Animals recovered within 3–4 days.

Sample collection: Samples from heart and foot lesions were collected during post-mortem in buffered glycerine saline. Blood samples were collected (n=24) from the ear vein and sera were screened for FMDV antibodies.

Serotype differentiating antigen detection ELISA: Supernatants of the homogenized clinical tissue materials were used in a serotype differentiating antigen detection ELISA as per Bhattacharya et al. (1996) for confirmation of serotype of the virus involved in the outbreaks.

Liquid phase blocking ELISA (LPBE): The test was performed as per the procedure described in OIE manual of standards for diagnostic tests and vaccines. A two fold dilution of test sera was carried out from 1:4 to 1:1024 for titration of antibodies.

NSP antibody detection ELISA: The test was performed using a Prionics FMD NS kit as per the manufacturer’s instructions. After colour development and stopping the reaction, the plate was read in ELISA reader (450 nm wavelength) and the absorbance values obtained were used to determine the percent-inhibition (PI) values. Serum samples having ≥50% PI values were considered as positive to NSP antibodies.

RESULTS AND DISCUSSION

The present outbreak of FMD in pigs in an organized farm was due to FMDV serotype O as confirmed by both sandwich-ELISA and multiplex-PCR at the ICAR-DFMD laboratory, Mukteswar. Outbreak of FMD in a private pig farm as well as organized cattle and pig farm due to FMDV serotype O has been reported earlier (Rout et al. 2016, Rout et al. 2017). In VP1 region-based phylogenetic analysis, the serotype O isolates causing the outbreak were found to conglomerate within Ind2001 lineage. Since 2013, the FMD outbreaks in the state of Karnataka are due to serotype O alone, affecting mainly the cattle. The pigs in the farm were not vaccinated against FMD. The farm was situated away from the village and no outbreaks in the surrounding village were reported. The probable source may be the hotel waste feed procured from restaurants located in nearby town. Pigs are much more susceptible to infection by the oral route than ruminants (Grubman and Baxt 2004). Outbreak in a South African pig farm in 2000 due to swill feeding, UK outbreak of FMD during the 2001 involving a swill-fed pig unit, feeding of contraband abattoir offal to pigs reared in close proximity to cattle causing the outbreak in Uruguay were the recent episodes of disease transmission in pigs attributed to animal feed contamination (Sutmoller et al. 2003, Paton et al. 2009). The clinical signs in the present outbreak were observed in the growing pigs with initial mortality in piglets. Once infection is detected in a pig farm, the spread of contact infection within the farm/herd begins sooner, through animal-to-animal transmission (Leon 2012). In the present episode, because of lack of awareness, the animals were not isolated and zoo-sanitary methods were not followed resulting in the disease spread to the whole farm.

During the clinical episode of the disease in the present outbreak, severe vesicular lesions typically on the snout and skin and around the coronary bands were observed in the affected pigs. Almost all affected animals were lame and recumbent due to the severity of lesions. The initial
clinical signs were loss of appetite and lameness with mild fever, inability to rise up, reluctance to move and body tremors due to pain. Epithelial surface showed necrosis with prominent raw ulcer observed. Severe erosions and ulcerations around the coronary band with sloughing of the claw were also evident in many affected pigs (Fig. 1). Coincident gross findings have earlier been reported (Leon 2012). Similar to the present outbreak, the incidence of the disease in non-immunized populations can be as high as 100% and mortality in piglets was also recorded in the affected herd as previously reported by others (Rovid et al. 2010). The farmer was immediately advised to separate the infected animals followed by disinfection of the premises on a daily basis, and other sanitary measures. Within 10 days the disease was under control without any further cases of FMD and associated mortality. The clinical materials collected during post mortem were found positive for serotype O antigen in antigen detection ELISA and mRT-PCR. In LPBE, 23 out of 24 pigs demonstrated log10 Ab titre of ≥1.8, against FMDV serotype O, while the titres against other serotypes were very low. Although any evidence of SP-Ab is taken as an indicator of virus infection in disease-free countries that do not practice vaccination, only a clear spike in SP-Ab response against any serotype can demonstrate infection associated antibodies reliably, in the context of an endemic region practicing vaccination, even with low coverage. Hence, a serotype specific ≥4-fold rise of LPBE titre (≥0.6 log10 titre difference) in comparison to other two component serotypes in the vaccine was the criterion to assess infection antibody response. Serotype O specific rise in the antibody titre was observed in pigs compared to serotype A and Asia-1 as a consequence of exposure to infection rather than vaccination with a trivalent vaccine. In NSP ELISA, infection associated antibodies could be detected in all serum samples confirming the virus activity in the herd. Simultaneous detection of both NSP-Ab positivity and serotype specific rise in SP-Ab titre substantiated the infection status of the animals (Fig. 2).

FMD affected pigs may liberate vast quantities of airborne virus in their exhaled breath and the aerosol spread of the disease reportedly occurs over more than 10 km from...
infected pigs to cattle downwind (Gloster et al. 1982, Donaldson 1987). In the present episode, the virus had spread to vaccinated cattle housed away from the pig herd and clinical lesions were observed in three vaccinated heifers. Movement of men or materials prone to contamination might have also played a role in spread of infection to the cattle. Most often, the spread of FMDV is associated with the movement of infected pigs which excrete large amount of virus in aerosal and ruminants get infected via inhalation of the infectious droplets (Alexandersen et al. 2003). Besides air borne spread from pigs to cattle, the disease transmission through animal attendants would have also played a role as no bio-sanitary measures were followed during the phase of outbreak.

In the present investigation, cattle housed in close proximity developed the disease though vaccinated 15 weeks back. Frank clinical signs including oral lesions in all the 12 animals with presence or absence of foot lesions were observed. However the animals recovered in 3–5 days. FMD infection was confirmed by detection of antibodies in the sera collected 18–22 days post recovery in cattle. Antibodies to both structural proteins (LPBE test) and non-structural protein (PrioCHECK FMD NS test) were detectable in the sera samples confirming the infection in cattle. This observation confirms that FMD transmission can occur in cattle despite FMDV vaccination status as animals had high exposure to virus following the wide spread infection in pigs in the adjacent herd. Though the vaccine-induced immunity was not assessed in this case, it could be expected that the serum titres would have been on the decline at 4 months post vaccination.

Though the vaccination based FMD-CP which involves biannual vaccination of all cattle, buffaloes and pigs is being implemented in the state since 2011, the farmer had not vaccinated the pigs. Hence creating awareness among farmers is necessary for controlling the disease. Training to improve the ability of disease recognition and reporting along with village-level biosecurity measures is of paramount importance in FMD ‘hotspots’ if sustainable initiatives at regional level meant for FMD control are to be actualized (Nampanya et al. 2013). The farming community should be well informed and trained about the clinical signs of FMD and strong awareness of the importance of prompt reporting of the disease to the official authorities must be created. Though pigs are covered under the FMD mass vaccination campaign, there is no focused approach on the vaccination of pigs in the commercial herds as they are maintained only for their productive life. However, this is important in view of the possible threat of transmission of the disease from pigs to the susceptible dairy herds.

ACKNOWLEDGEMENTS

We thank the Directors of KVAFSU-IAH&VB, ICAR-DFMD and ICAR-IVRI institutes for providing the facilities and logistics used in the study. We sincerely thank the farmer who permitted us to collect blood samples from the herd. Editorial assistance rendered by Mr Ram Prasad Susarla is also gratefully acknowledged.

REFERENCES

Alexandersen S, Zhang Z, Donaldson A I and Garland A J M. 2003. The pathogenesis and diagnosis of foot-and-mouth disease. Journal of Comparative Pathology 129: 1–36.

Bhattacharya S, Pattnaik B and Venkataramanan R. 1996. Development and application of sandwich enzyme linked immunosorbent assay (ELISA) for the type identification of foot and mouth disease (FMD) virus in direct field materials. Indian Journal of Animal Sciences 66: 1–9.

Brown C. 2001. Update on foot and mouth disease in swine. 2001. Journal of Swine Health and Production 9: 239–42.

Donaldson A I. 1987. Foot and mouth disease: the principal features. Irish Veterinary Journal 41: 325–27.

Donaldson A I and Alexandersen S. 2003. The virological determinants of the epidemiology of foot and mouth disease. (Eds) Dodet B and M. Vicari. Foot and mouth disease: control strategies. Éditions scientifiques et mé dicales Elsevier SAS, France. pp. 173–80.

Gloster J, Sellers R F and Donaldson A I. 1982. Long distance transport of foot-and-mouth disease virus over the sea. Veterinary Record 110: 47–52.

Grubman M J and Baxt B. 2004: Foot-and-mouth disease. Clinical Microbiology Reviews 17: 465–93.

Leon E A. 2012. Foot-and-mouth disease in pigs: current epidemiological situation and control methods. Transboundary and Emerging Diseases 59: 36–49.

Nampanya S, Richards J, Khounsy S, Inthavong P, Yang M, Rast L and Windsor P A. 2013. Investigation of foot and mouthdisease hotspots in northern Lao PDR. Transboundary and Emerging Diseases 60: 315–29.

OIE 2018. Foot and mouth disease, chapter 2.1.8. Manual of Diagnostic Tests and Vaccines for Terrestrial Animals 2018. Available at www.oie.int/standard/terrestrial-manual/access online, accessed on 17-12-2018.

Paton D J, Sumption K J and Charleston B. 2009. Options for control of foot-and-mouth disease: knowledge, capability and policy. Philosophical Transactions of the Royal Society B: Biological Sciences 364: 2657–67.

Rout M, Pawar S S, Nair N S, Benjamin E D, Usha A P, Anil K S, Mohapatra J K, Subramaniam S and Pattnaik B. 2016. Detection of foot and mouth disease virus infection in cattle and pigs at Mannuthy, Kerala. Indian Journal of Veterinary Pathology 40: 55–57.

Rout M, Subramaniam S, Mohapatra J K, Dash B B and Pattnaik B. 2017. Investigation of foot-and mouth disease outbreak in a pig farm at Kollam districtof Kerala, India. Indian Journal of Animal Research. DOI:10.18805/ijar.B-3071

Rovid Spickler, A, Roth A, Gaylon J and Lofstedt J. 2010. Emerging and Exotic Diseases of Animals. 4th edn. Iowa State University, Iowa Publishing Professional, Ames, Iowa, USA. 517–36.

Subramaniam S, Pattnaik B, Sanyal A, Mohapatra J K, Pawar S S, Sharma G K, Das B and Dash B B. 2012. Status of foot and mouth disease in India. Transboundary and Emerging Diseases 60: 197–203.

Sutmoller P, Barteling S S, Casas Osalcoaga R and Sumption K J. 2003. Control and eradication of foot-and-mouth disease. Virus Research 91: 101–44.