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Foot and Mouth Disease (FMD): an ongoing threat to Bovines

Sonali Mishra[1], Bhupesh Kamdi[2*] and Kunal Pandit[3]

[1]Assistant Professor, Department of Veterinary Clinical Complex, DGCN COVAS, CSK HPKV. Palampur. 176062. H.P.
[2]Assistant Professor, Department of Veterinary Pathology, Post Graduate Institute of Veterinary and Animal Sciences, Akola Maharashtra, India
[3]Veterinary officer, VHLambagaon, Department of Animal Husbandry, Himachal Pradesh

[*]Corresponding author: bhupeshkamdi@gmail.com

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Abstract
Foot-and-mouth disease (FMD) is a highly contagious viral disease that affects cloven-hoofed animals, including domesticated livestock and wildlife species. FMD can cause acute vesicular disease, leading to significant economic losses in the livestock industry due to reduced productivity, trade restrictions, and control measures. The disease's impact on wildlife populations further emphasizes its ecological importance. The first documented description of FMD dates back to 1514, and since then, extensive research has contributed to our understanding of the virus and its transmission dynamics. This article highlights its persistence as a major global concern. The evolving nature of the virus, including its genetic diversity and antigenic variation, poses challenges for effective control and vaccination strategies. Understanding the epidemiology and impact of FMD is crucial for developing comprehensive control measures and mitigating the economic and ecological consequences associated with this devastating disease.

Keywords: Apthovirus, Bovines, FMD

Introduction

Foot-and-mouth disease (FMD) is a severe, viral disease of cloven-hoofed animals including domesticated ruminants and pigs. It can affect more than 70 wildlife species and cause clinically acute vesicular disease (Coetzer*et al*., 1994). The first written description of FMD was in 1514, when Fracastorius described a disease of cattle in Italy. Almost 400 years later, in 1897, Loeffler and Frosch demonstrated a filterable agent that caused FMD (Loeffler and Frosch, 1897). The economic losses due to reduced milk production, reduced draught power, lameness, infertility from FMD cannot be ignored. Since then, FMD has continued to pose a significant threat to global animal health and the livestock industry. FMD is an OIE list A disease, which means it has the potential for rapid and extensive spread within and between countries and can cause severe economic losses. The etiological agent of FMD is a highly contagious RNA virus classified under the genus Aphthovirus (Grubman and Baxt, 2004). The virus spreads primarily through direct contact with infected animals or contaminated fomites. This article emphasizes the importance of strict biosecurity measures in preventing the introduction and spread of FMD.

Etiology

The Foot-and-mouth disease virus (FMDV) is a member of the *Picornaviridae* family and is classified within the Aphthovirus genus. It has a positive-sense, single-stranded RNA genome that is approximately 8.4 kilobases in size (Belsham, 1993).Seven distinct serotypes of FMDV, have been defined and includes types O, A, C, Southern African Territories (SAT) 1, SAT 2, SAT 3 and Asia 1; multiple subtypes occur within each serotype (Bachrach 1968).
The genome encodes a single polyprotein that is subsequently cleaved into both structural and non-structural proteins. The structural proteins include VP1, VP2, VP3, and VP4, which are responsible for the viral particle assembly. The viral genome is surrounded by four structural proteins to form an icosahedral capsid (Rueckert 1996). The non-structural proteins, on the other hand, play crucial roles in viral replication and evasion of host immune responses (Belsham, 1993). One important aspect of FMDV is its genetic diversity. The virus exhibits significant genomic variations, both within and between different serotypes, which contributes to the complexity of the disease (Belsham, 1993). These genetic differences can result in changes in antigenic properties, allowing the virus to evade host immune responses and develop antigenic variants. This antigenic

variation poses challenges for disease control and vaccination strategies. It requires the constant monitoring and updating of vaccine strains to ensure their efficacy against circulating FMDV strains (Grubman and Baxt, 2004).

The high mutation rate and genetic variability of FMDV contribute to its ability to adapt and persist in different host populations. This genetic diversity, combined with antigenic variation, allows the virus to evade host immune responses and pose challenges for disease control and eradication efforts. These factors highlight the importance of surveillance, strict biosecurity measures, and the development of effective vaccines tailored to prevailing FMDV strains (Belsham, 1993).

FMDV is capable of infecting a wide range of hosts, primarily cloven-hoofed animals, including domesticated livestock such as cattle, pigs, sheep, and goats. However, the virus can also affect wildlife species, such as deer and buffalo. The susceptibility to FMDV infection varies among species, and even within different breeds of the same species. Factors such as age, immune status, and genetic background can influence susceptibility to infection and the severity of clinical signs.

Prevalence

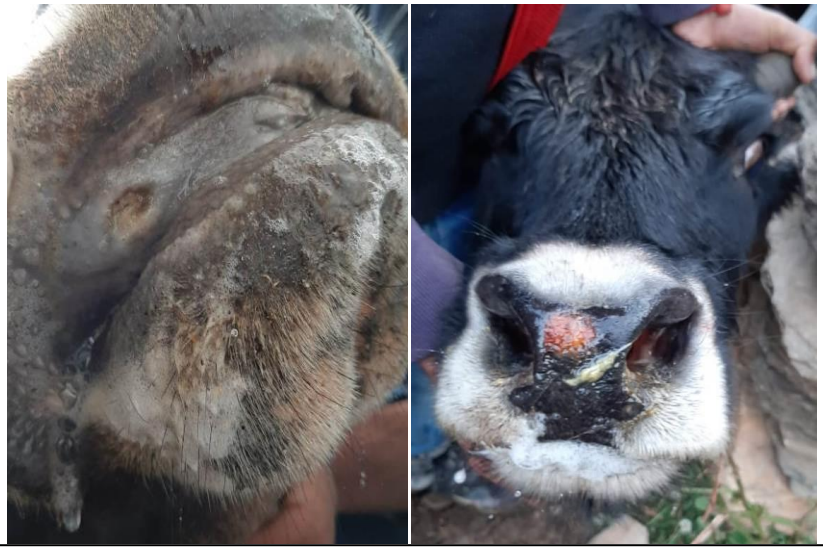
The prevalence rates of FMD geographically varies being 43% in Eastern region, 31.5% in Southern region, 11.6% in North-eastern region, 5% in central region, 4.4% in Western region and 4% in Northern region (Subramanian *et al*., 2013). FMD is endemic in India with higher prevalence of serotype O, A and Asia1. The number of confirmed outbreaks revealed 80% , 12% and 8% seropositivity of serotype O, Asia 1 and A . The disease is more prevalent in cattle (16.51% and 25.84% in adult cattle and young cattle, respectively) than in buffaloes (11.01%, 10.34% in adult and young buffaloes, respectively) (Thirunavukkarasu and Kathiravan 2010). The most favorable period of the year for the emergence of FMD is September (post monsoon) and is lowest in June. Unrestricted animal movements in the country play a major role in the spread of FMD (Subramanian *et al*., 2013).

Pathogenesis

FMDV can infect animals as a result of direct (inhalation and ingestion) or indirect contact with infected animals or infected environment. Aerial transfer of droplets is the most common mode of transmission. Airborne transmission of virus depends upon various factors such as animal species, number and location of the transmitting and recipient animals, and favourableenvironmental conditions (Alexanderson *et al.,* 2013). FMDV can also gain entry from skin abrasions which, however, needs 10,000 times more virus particles. After gaining entry, the virus invades areas subjected to mechanical trauma or may settle in pharyngeal wall, thus gaining access to blood stream causing viraemia. Subsequent localization of virus (in 3 to 8 days) in buccal mucosa, teats and feet, results in development of vesicles. Virus is excreted into the milk of dairy cattle (Ray *et al.,* 1989) and also in semen, urine and faeces of affected animals (Kitching 1992). Some convalescent animals may remain carriers for months as the virus may persist in pharyngeal areas of such animals. Sloughing of the skin from teats and loss of horny cover from the hooves may be noticed in later stages. Secondary bacterial infections may aggravate the condition leading to development of mastitis and lameness. In calves, the virus may damage the cardiac muscle causing heavy mortality and tigroid heart appearance (a pathogonomic lesion) (Sharma *et al.,* 2019).

Clinical findings

The incubation period of FMD varies from 2 to 14 days and depends on the infecting dose and route of infection (Grubman and Baxt, 2004). Painful stomatitis develops within 2 days and is characterized by profuse salivation, smacking of lips, ropy saliva hanging from lips (Figure 1a). The disease sets in with high fever, which subsides later. The disease manifestations include characteristic vesicle formation on buccal mucosa, dental pad, tongue, muzzle (Figure 1b), teats, mammary gland, prepuce, vulva and on feet (coronet and in the clefts). The resultant pain due to ruptured vesicles / sloughing of horn from hoof (thimbling) causes lameness, manifested by foot "flicking", a tucked- up stance and reluctance to stand or walk, as well as inappetance (Alexanderson *et al.,* 2013). Pregnant animals may abort and vesicles on teat may lead to reduced milk yield and secondary mastitis. Sero-fibrinous exudates may be seen covering the vesiculated areas of the skin within few days. Mortality is higher in young animals due to malignant form of disease leading to heart failure. Panting (due to endocrine damage), mastitis, lameness, infertility, diabetes mellitus and reduced heat tolerance are the common consequences of the disease. (Sharma *et al.,* 2019)



(Fig.1a-showing ruptured vesicle on dental pad with ropy salivation &Fig. 1b- showing ruptured vesicle on the muzzle.) Images taken from outbreak of FMD at KillarPangi valley H.P.

Diagnosis

Laboratory confirmation of FMDV is done by ELISA detection of specific FMDV antigens in epithelial tissue suspensions. RT-PCR assays, complement fixation test are also used for diagnosis of FMDV (Sharma *et al.,* 2019).Viral detection from ELISA needs samples having high titres of FMDV ie. vesicular epithelium, fluid etc. The more sensitive methods, such as RT-PCR, gives positive results even from the samples containing smaller amounts of virus ie. blood, swabs, faeces etc. (Ferris *et al*., 1990)

Prevention and control

Prevention and control of FMD consists of biosecurity and vaccination. Restricted movements of animals between FMD endemic and free areas, along with disinfection of premises and infected material needs to be done. In endemic countries or zones, culling may be complemented with vaccination for susceptible livestock (Mishra *et al*., 2017). Ring vaccination should be done to contain the outbreak in the containment area and farms should be left unstocked for at least 6 months. In India tetravalent (O, A, C and Asia1) vaccines are in use which should be done biannual at 4 and 8 months of age in calves from unvaccinated dams and at 6 and 10 months from vaccinated dams. In cattle, vaccination should be done between 100 and 180 days of pregnancy (Sharma *et al.,* 2019).

Conclusion

Foot-and-mouth disease (FMD) remains a significant threat to livestock and wildlife populations worldwide. Despite substantial advancements in research and control strategies, the genetic diversity and antigenic variation of the virus continue to pose challenges for effective prevention and control measures. To adequately address FMD, a multilateral approach is necessary, involving collaboration between veterinary authorities, researchers, and stakeholders. This includes implementing strict biosecurity measures, enhancing surveillance systems, and improving vaccination strategies. Continued investment in research, diagnostics, and vaccine development is essential to combat FMD effectively. Overall, a comprehensive and integrated approach is crucial for mitigating the impact of FMD, reducing economic losses, and safeguarding livestock and wildlife populations against this devastating disease.

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