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Research Article

Changes in Serum Biochemical Values in Adult Cattle with Foot and Mouth Disease

Oguzhan Avci[1*], Sibel Yavru[1] and Murat Sevik[2]

[1] Department of Virology, Faculty of Veterinary Medicine, University of Selcuk, 42003, Konya, Turkey
[2]Veterinary Control Institute, 42080, Konya, Turkey
***Corresponding author:** oavci@selcuk.edu.tr

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ABSTRACT

The aim of this research was to determine the changes in serum biochemical values of adult cattle with foot and mouth disease (FMD). Blood samples were obtained from adult Holstein cattle with FMD (n=7) and healthy cattle (n=5, control). Serum was extracted from these, and cardiac, hepatic, and renal damage markers, as well as lipid metabolism products and phosphorous levels were measured. High-density lipoprotein levels were 97.5±23.6 mg/dL and 145.2±10.9 mg/dL in cattle with FMD and control animals, respectively, and these values were significantly different ($P<0.001$). Blood urea nitrogen levels were 26.5±8.28 mg/dL and 41.4±7.53 mg/dL in cattle with FMD and control animals, respectively, and these values were significantly different ($P<0.05$). In conclusion, it may be stated that FMD does not cause significant changes in cardiac, hepatic, or renal damage markers, or in lipid metabolism products or phosphorous levels in adult cattle, as the measured values were not significantly different from those of healthy cattle. These results may useful for the diagnosis of FMD, as well as for the evaluation of other laboratory findings.

Key words: Biochemical Values, Blood, Cattle, Foot and Mouth Disease, Serum

INTRODUCTION

Foot and mouth disease (FMD), a highly contagious viral disease of zoonotic character (Grubman and Baxt 2004), which has a negative impact on the international trade of live animals and animal products (Valarcher *et al.*, 2008), is observed in domestic and wild ruminants, including cattle, sheep, goats, and pigs, and it has significant economic effects (Mohana *et al.*, 2012).

The FMD virus (FMDV), which taxonomically belongs to the *Aphthovirus g*enus in the *Picornaviridae* family, contains a single strand of RNA and lacks an envelope (Belsham 1993). The capsid is composed of four structural proteins, namely, VP1, VP2, VP3, and VP4. Sixty copies of each of these structural proteins form an icosahedral symmetry (Huang *et al.*, 2011). Immunologically, FMDV is divided into seven serotypes (O, A, C, SAT 1, SAT 2, SAT 3, and Asia 1), which are further classified into several subtypes (Rueckert, 1996). The lack of cross-immunity between serotypes further complicates the control of FMD. In infected carcasses, FMDV is rapidly inactivated at 4ºC within 24–48 hours due to the generation of lactic acid, but may persist in blood, bone marrow, lymph glands, and internal organs for a longer time period. FMDV may also remain active for an extended period in skeletal muscles in the event of the rapid freezing of carcasses (Doel *et al.*, 1994). FMDV, which is labile to chemical agents, remains stable from pH 7.0 to 7.7, yet is rapidly inactivated under acidic and alkaline conditions (Kitching and Donaldson, 1987). Under laboratory conditions, FMDV can reproduce in bovine thyroid cell cultures, ovine or porcine kidney, tongue epithelial (Gurhan and Ozturk, 1995) or Baby Hamster Kidney-21 continuous cell lines (Huang *et al.*, 2011).

The laboratory diagnosis of FMD is performed by means of the complement fixation test (Ferris and Dawson, 1988), virus isolation from cell culture (Gurhan and Ozturk, 1995), virus identification, and multiplex PCR and Pen-side (Strip) tests. The presence of antibodies is detected using serological tests, including the virus neutralization test (Golding *et al.*, 1976), solid phase competition ELISA (SPCE; Paiba *et al.*, 2004), and liquid-phase blocking ELISA (LPBE; Hamblin *et al.*, 1987). Due to its serotype specificity, high sensitivity, and ability to differentiate between post-vaccination and post-infection antibodies, as well as the ability to test several samples simultaneously, ELISAs are frequently used for

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the detection of FMDV in suspensions prepared from epithelial lesions. Furthermore, for the purpose of genetic sequence analysis, the reverse transcription–polymerase chain reaction (RT-PCR), real-time quantitative PCR, and nucleotide sequencing are applied (Zhang *et al.,* 2013).

It has been reported that FMD causes some hematological and biochemical alterations that result in damage to several organs, tissues, and systems (the heart, liver, kidneys, lipid and protein metabolism, and the fluid-electrolyte balance) (Sahal *et al.,* 1994, Or and Fidanci, 2009). Researchers have reported that, in cattle, FMD causes degeneration of the heart muscle (myocarditis, a striped appearance referred to as "tiger heart") and skeletal muscle, particularly in young animals (Elitok *et al.,* 1999, Gokce *et al.,* 2004), and that it increases the level of cardiac damage markers (Elitok *et al.,* 1999, Tunca *et al.,* 2008). Bolukbasi *et al.,* (1987) suggested that disorders caused by infection with the O1 serotype of FMDV affect the bioelectrical potential of the heart, resulting in significant alterations in electrocardiograms. Furthermore, in field studies conducted by the Foot and Mouth Disease Institute of the Ministry of Food, Agriculture, and Livestock of the Republic of Turkey, necropsies performed on a large number of young animals that suffered per acute deaths revealed that myocardial infarctions were the cause of death (Sutcu, 1985). The FMD mortality rate is 5% for adult animals and can increase up to 50% in young animals as a result of myocardial degeneration (Barnett and Cox, 1999).

In view of the hypothesis that FMD may cause biochemical alterations in cattle, this study aimed to determine any possible changes in the serum biochemical parameters of healthy adult cattle and infected with FMDV.

MATERIALS AND METHODS

Animals and Samples

Twelve Holstein cattle were used, including seven cattle (from Konya, aged 3 to 5 years) infected with FMDV (the positive group) and five cattle that were not infected with FMDV (the control group) according to test results from the Foot and Mouth Disease Institute (Ankara, Turkey). Blood samples were taken from the jugular vein using sterile vacuum tubes (Vacutainer, BD, Franklin Lakes, NJ, USA) containing kaolin. Serum samples were prepared from blood samples by centrifugation at 2000 rpm for 10 min. Serum samples were placed in sterile eppendorf tubes and taken to the laboratory for processing within 30 min.

Analysis of parameters

Creatine kinase (CK), creatine kinase-myocardial band (CK-MB), lactate dehydrogenase (LDH), aspartate aminotransferase (AST), gamma glutamyltransferase (GGT), total protein (TP), albumin, creatinine, blood urea nitrogen (BUN), cholesterol, triglycerides, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and phosphorous levels in serum were determined using an auto-analyzer (ILab–300, BioMérieux Diagnostic, Florence, Italy) using a commercially available test kit (IL Test, Instrumentation Laboratory, Italy).

Statistical analyses

Values were expressed as means ± standard deviations. Differences between groups were calculated using an independent-samples T test (SPSS 19.0 for Windows). Differences were considered significant for $P< 0.05$.

RESULTS

The serum biochemical values obtained from both groups are given in Table 1. HDL ($P<0.001$) and BUN values were significantly different ($P<0.01$) between the FMD positive and negative groups.

Table 1: Serum biochemical values in FMDV-infected and non-infected adult cattle.

Parameter	FMD* positive	FMD negative	P
CK (U/L)	269±133	248±145	P>0.05
CK-MB (U/L)	351±85.5	312±64.6	P>0.05
LDH (U/L)	1933±350	1780±87.6	P>0.05
AST (U/L)	81.1±15.7	96.6±49.6	P>0.05
GGT (u/L)	16.7±4.68	19.4±12.1	P>0.05
TP (g/L)	73.4±12.0	75.8±6.76	P>0.05
Albumin (g/dL)	31.8±2.19	34.4±1.94	P>0.05
Creatinine (mg/dL)	74.0±33.5	72.2±17.4	P>0.05
BUN (mg/dL)	26.5±8.28	41.4±7.53	P<0.01
Cholesterol (mg/dL)	325±115	361±25.3	P>0.05
Triglycerides (mg/dL)	18.7±11.3	15.0±12.1	P>0.05
LDL (mg/dL)	32.0±12.5	26.6±1.81	P>0.05
HDL (mg/dL)	97.5±23.6	145.2±10.9	P<0.001
Phosphorous (mg/dL)	70.0±14.0	71.8±15.9	P>0.05

*FMD: foot and mouth disease, CK: creatine kinase, CK-MB: creatine kinase myocardial band, LDH: lactate dehydrogenase, AST: aspartate aminotransferase, GGT: gamma glutamyltransferase, TP: total protein, BUN: blood urea nitrogen, LDL: Low-density lipoprotein, HDL: High-density lipoprotein.

DISCUSSION

It is known that, across the globe, in ruminants, FMD causes reduced meat and milk yields, poor fleece quality, and, particularly in the young, mortality due to myocarditis. It has been reported that the antioxidant level is affected (Yarim *et al.,* 2006, Or and Fidanci, 2009), the serum albumin level is reduced, and gamma-globulin levels are increased (Or and Fidanci, 2009) in animals infected with FMDV, while the administration of FMD vaccines causes alterations in mineral levels (Karademir 2007).

Myocardial damage is detected based on alterations in blood myoglobin, CK, CK-MB, LDH, and AST levels. It has been determined that CK activity in skeletal muscle (CK-MM) and the myocardium (CK-MB) is greater than that in the brain (CK-BB) (Kaneko *et al.,* 2008). In the present study, it was ascertained that FMD had no effect on myocardial damage markers (CK, CK-MB, LDH, AST) ($P>0.05$) (Table 1). Previous research has demonstrated the occurrence of myocardial damage in cattle infected with the bluetongue virus and FMDV (Radostits *et al.,* 2007). It has been reported that CK-MB levels are elevated in infections characterized by cardiac damage (Porciello *et al.,* 2008), and that FMD causes damage to the heart, particularly in young animals,

resulting in elevated troponin I levels (Karapinar *et al.*, 2010). It has been suggested that troponin I levels increase in calves infected with FMD, and that this increase can be considered to be a marker of myocardial degeneration (Tunca *et al.*, 2008). Studies also indicate that FMD leads to increases in CK, CK-MB, LDH, and AST levels (Elitok *et al.*, 1999, Tunca *et al.*, 2008). Researchers have indicated that FMDV alters the biochemical potential of the heart and causes significant alterations in electrocardiograms (Bolukbasi *et al.*, 1987). Gunes *et al.*, (2005) reported a twofold increase in ALP, AST, and LDH concentrations in a calf infected with FMD. Increases in AST and LDH levels are considered to be indicators of myocardial degeneration. However, it has also been shown that AST and LDH levels may increase in the event of the breakdown of skeletal muscle and hepatic tissue (Kaneko *et al.*, 2008). In the present study, there was no statistical difference between the AST, LDH, CK, and CK-MB levels in infected and non-infected animals, which suggests that FMDV does not cause muscle degeneration in adult animals.

The results of the present study demonstrated statistical differences between the serum HDL and BUN values of the healthy and infected groups ($P<0.05$) (Table 1). It has been reported that viral agents may affect the serum biochemical parameters including kidney and lipid metabolism values (Moriya *et al.*, 2003, Bozukluhan *et al.*, 2015). Gokce *et al.*, (2004) reported that serum total protein, albumin, cholesterol, triglyceride, and calcium levels were reduced in cattle infected with FMD. In view of the parameters investigated and the values that were significantly different between the infected and non-infected groups in the present study, it was concluded that FMD does not have significant effects on the liver, kidneys, and lipid metabolism in adult cattle. In animals, albumins constitute 35%–50% of total serum proteins. It has been indicated that blood albumin and protein concentrations may change according to the physiological and pathological conditions of animals (Batamuzi *et al.*, 1996). In the present study, the albumin and total protein concentrations of adult cattle infected with FMDV were lower than those of healthy adult cattle, yet this alteration was confirmed to be within the reference range reported for cattle (Kaneko *et al.*, 2008).

Conclusion

It is suggested that FMD causes no significant damage to the heart, liver, and kidneys in adult cattle; however, depending on the serotype of the FMDV, the host animal species, and the age of the host, the effect of FMDV on the internal organs and systems may vary.

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