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COMPARISON OF ECHOCARDIOGRAPHICINDICES OF NORMAL BUFFALOES AND THOSE HAVING DIAPHRAGMATIC HERNIA

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ABSTRACT
The objective of this study was to describe the clinical presentation and evaluate echocardiographic findings in Murrah buffaloes suffering from diaphragmatic hernia. Normal buffaloes (n=15) and buffaloes with diaphragmatic hernia (n=15) diagnosed clinically, radiographically, ultrasonographically for diaphragmatic hernia were evaluated in this study. Fifteen healthy buffaloes were included in this study as controls. The mean±SE value of left ventricular internal diameter at diastole and systole (LVIDd and LVIDs) (cm), end diastolic volume (EDV) (ml), end systolic volume (ESV) (ml), stroke volume (SV) (ml), cardiac output (CO) (%), and left ventricular posterior wall thickness at systole (LVPWs) (cm) were significantly decreased whereas other parameters were non significantly changed. In conclusion, theLVIDd, LVIDs, EDV, ESV, SV and CO were significantly decreased and FS (fractional shortening) was increased significantly in cases of buffaloes affected with diaphragmatic hernia as compared to normal.
Keywords: Buffaloes, heart, echocardiography, diaphragmatic hernia.

INTRODUCTION

Diaphragmatic hernia (DH) is one of the disorders inducing mortality in buffaloes (Mohindroo*et al.*, 2007). It has been described as a congenital or acquired condition in bovine (Athar *et al.*,2010 and Bellavance *et al.*, 2010). Generally, violent trauma and increase in intra-abdominal pressure constitute the main causes of diaphragmatic hernia in animals. Echocardiography is specific when the right and left ventricular filling pressures are unequally elevated. Recently, ultrasonography has been proven in diagnosis of diaphragmatic hernia in cattle (Kumar and Saini, 2012). To our knowledge, the little reports on ultrasonography of diaphragmatic hernia in cattle were focused only on reticular motility and location. Shape and frequency of reticular motility as well as its relation to surrounding thoracic organs like lung and heart have never been evaluated.Real-time two-dimensional echocardiography has been used to visualize cardiac structures and their motions and has been highly appraised (Yamaga& Too, 1984,Pipers *et al.,* 1985 and Ware *et al.*, 1986). M-mode study can be performed to take different cardiac measurements associated with diaphragmatic hernia in parasternal long axis and the short axis. Echocardiographic images are also used to acquire quantitative information about cardiac function. Mathematical formulas are then applied to determine values for cardiac output, ejection fraction, ventricular wall stiffness, and other cardiac functions. The measurements obtained from the parasternal long axis and short axis m-mode can also be used to assess the left ventricular systolic function (Schobar and Baade, 2000). The perusal of the available literature revealed that very limited work has been done to study the impact of DH on structure and function of heart, therefore, this study was designed to describe the echocardiographic indices in buffaloes suffering from diaphragmatic hernia.

MATERIALS AND METHODS

a. HISTORY AND CLINICAL EXAMINATIONS

ThirtyMurrah buffaloes (*Bubalusbubalis*) were examined in the Department of Surgery and Radiology, College of Veterinary Science, Guru AngadDev Veterinary and Animal Sciences University, Ludhiana, Punjab, India.The buffaloes, (n=15) presented to the hospital for superficial injury like teat abrasion, skin trauma, were considered as control group for echocardiographic evaluation, clinical parameters (heart rate, respiration,ECG and heart sound) were normal. Most of the animals diagnosed clinically and ultrasonographically for diaphragmatic hernia were parturated recently or were pregnant and in the last trimester.Buffaloes were referred to the hospital becauseof edema, anorexia, sharp drop in milk yield, abdominaldistension, and recurrent tympany. The duration of illnessvaried from 1 to 2 weeks before admission. There was ahistory of previous medications including antibioticinjections, fluid therapy, and general tonics by the fieldveterinarians for buffaloes having DH (n=15), butwithout obvious improvement. All animals were examinedclinically as described before which included general condition and auscultation of the heart, lungs, and rumen. In addition, rectal temperature and respiratoryand heart rates were also recorded. The general health condition of most of the animals was deteriorated.

b. HAEMATOLOGY

Two ml of blood was drawn by venipuncture of the jugular vein using 18 gauze hypodermic needle and transferred to the sterile vial containing ethylene Diamine Triacetate (EDTA). From the pooled blood, routine haematology was performed which included red blood cells (RBCs), Haemoglobin (Hb), Total leukocyte count (TLC), Differential leukocyte count (DLC) and Packed cell volume (PCV).

c.STATISTICAL ANALYSIS

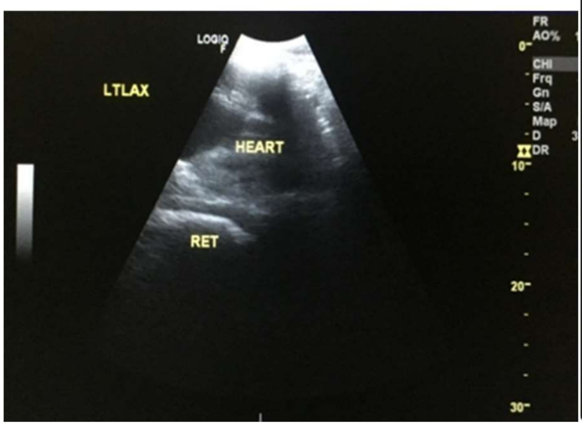
Descriptive statistical analysis was performed using SAS 9.4 (SAS institute USA). Student t-test with two sample assuming unequal variance was used to determine the significant difference between two groups. The objective data was calculated for mean ± SE wherever applicable with the level of significance considered at 5%. The resultant data was presented as mean ± SE for each parameter.

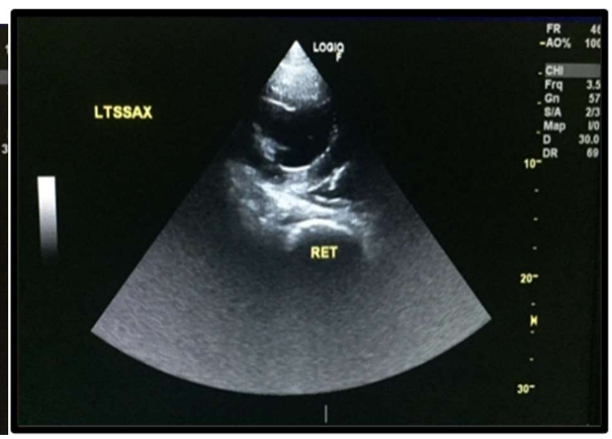
d.ECHOCARDIOGRAPHIC EXAMINATION

The echocardiography was performed between the 3rd to 5th intercostal spaces on both the sides of the thorax after application of ultrasound gel over the shaved area.Echocardiography was conducted on standing animal by using GE Healthcare F 8 ultrasound machine equipped with cardiac probe of frequency ranging from 2.8 to 3.6 MHz.None of the animal was sedated or tranquilized. The left parasternal long axis view was obtained at 4th intercostal space, 9-11 cm above the olecranon, transducer was directed cranio-dorsally with a rotation of 0-40^{0}. The structures visible were left ventricle, left ventricular outflow tract, aortic valve, aorta, right atrium and right ventricle. Once the structures such as left ventricle, left ventricular outflow tract, right ventricle were visible, the M-mode cursor was placed at the level of chordae and M-mode images were obtained. The M-mode images for study of left atrial diameter were taken by placing the M-mode cursor to the level of aorta and left atrium. The M-mode measurement of the right ventricular internal diameter at diastole (RVIDd), interventricular septum thickness at end diastole (IVSd) and end systole (IVSs), left ventricular internal diameter at end diastole (LVIDd) and end systole (LVIDs), left ventricular posterior wall thickness at end diastole (LVPWd) and end systole (LVPWs) were obtained in normal buffaloes as well as affected with diaphragmatic hernia.

e. DIAGNOSIS

Based on the clinical examinationsthe diseased buffaloes were classified into 2 groups- group 1 with normal buffaloes (n=15) and group 2 with diaphragmatic hernia (n=15).Theclinical signs of dullness, depression, anorectic,tympany, scanty feces and regurgitation of food from mouth,respiratory distress and abnormal lung sound. In radiograph, the diaphragm line was not clear and herniated part of reticulum was observed in the thoracic cavity and cardiac silhouette was not clear. These findings can be attributed to impaired process of eructation and rumination as a complication of reticular herniation. This might be due to lung irritation or heart displacement by herniated reticulum (Fig. 1and 2).





3. RESULTS AND DISCUSSION

a. CLINICAL PRESENTATION AND CLINICAL FINDINGS

Clinical findings of 15 buffaloes were recorded in buffaloes with diaphragmatic hernia.Ruminalhypo motility is considered a sign of indigestion, while the hypermotile rumen might be due to development of vagal indigestion secondary to diaphragmatic hernia.The temperature of animals affected with diaphragmatic hernia was non-significantly increased in buffaloes in comparison to normal but was in normal physiological range whichcould be due to inflammation(Table.1). The respiration rate of buffaloes having diaphragmatic hernia were increasedsignificantly(Table.1).Increased respiration rate (71.6±14.9/min), high rectal temperature (103.5±0.3°F) and increased heart rate (95.6±4.9bpm) in three buffaloes positive for DHwasreported by Abdelaal *et al.* (2014). The heart rate of buffaloes having diaphragmatic hernia was non significantly increased in comparison to normal.Talekar*et al*. (2018) observed in a study in four Jaffarabadi buffaloes affected with diaphragmatic hernia the range of the pulse rate (59 to 63/minute), respiration rate (18 to 21/minute), heart rate (57 to 60/min).

Table 1: TABLE DEPICTING CLINICALPARAMETERS IN NORMAL BUFFALOES AND THOSE AFFECTED WITH DIAPHRAGMATIC HERNIA.

Parameters	Normal (n=15)	Diaphragmatic hernia (n=15)
Age (years)	7.53±0.48 (5.00-12.00)	8.46±0.71 (5.00-14.00)
Body weight (kg)	378.46±10.02 (300.00-450.00)	347.00±15.97 (250.00-450.00)
Respiration rate (per minute)	36.13±1.57 (27.00-46.00)	46.00±0.61** (43.00-50.00)
Heart rate (beats/min)	57.70±0.32 (54.41-59.76)	65.69±0.21 (54.21-68.87)
Rectal temperature^{0}F	100.47±0.11 (100.00-101.40)	100.98±0.17 (100.00-102.00)

NS $p \geq 0.05$,*$p<0.05$,**$p<0.01$

Clinical, hemato-biochemical and ultrasonographic findings in egyptian buffaloes with diaphragmatic hernia in a study and observed that the body temperature, respiration rates, heart sound and ruminal movement were normal (Attia, 2016). In case of diaphragmatic hernia, on auscultation, muffled splashing heart sound were heard. Similar findings were observed by *Gavaliet al*.(2003).

In buffaloes affected with diaphragmatic herniaas compared to the normal group, the mean±SE of heamoglobin (g/dl) and monocyte count (%) were decreased non significantly,whereasthelymphocyte (%) was decreased significantly. The total leukocyte count (x10^3), RBCs count and packed cell volume (%) were increased non significantly and neutrophils (%) was increased significantly in comparison to normal buffaloes. These observed haematological alterations were might be due to infection, decreased feed and water intake or anorexia(Table.2).

Table 2: TABLE DEPICTING HAEMATOLOGICAL PARAMETERS OF NORMAL BUFFALOES AND THOSE AFFECTED WITHDIAPHRAGMATIC HERNIA.

Parameters	Normal (n=15)	Diaphragmatic Hernia (n=15)
Haemoglobin(g/dl)	12.02±0.33 (10.00-14.00)	10.42±0.30 (8.21-11.90)
Red blood Cells(x 10^6)	5.84±0.17	7.49±0.25

	(5.00-6.90)	(5.90-8.65)
Packed cell volume (%)	35.64±0.74 (30.15-39.06)	36.99±0.56 (30.90-39.33)
Total leucocyte count (x10^3)	10.25±0.20 (8.99-11.70)	10.40±0.11 (9.31-10.85)
Neutrophils(%)	56.31±0.47 (54.11-59.88)	61.08±3.07** (36.30-77.60)
Lymphocyte(%)	39.31±0.07 (38.92-39.83)	33.92±1.63** (20.10-46.12)
Monocyte (%)	2.33±0.06 (1.87-2.67)	1.75±0.10 (1.10-2.67)

NS p≥0.05,*p<0.05,**p<0.01

The mean±SE value of left ventricular internal diameter at diastole and systole (LVIDd and LVIDs) (cm), end diastolic volume (EDV) (ml), end systolic volume (ESV) (ml), stroke volume (SV) (ml), cardiac output (CO) (%), and left ventricular posterior wall thicknessat systole (LVPWs) (cm) were significantly decreased whereas left ventricular posterior wall thickness at diastole (LVPWd) (cm), Cardiac index (CI) (lit/m^2) and interventricular septum thickness at systole and diastole (IVSd and IVSs) (cm) were non significantly decreased in buffaloes affected with DH as compared to the normal animals. The fractional shortening (FS) (%) was significantly increased and ejection fraction (EF) (%)wasnon- significantly increased in buffaloes with DH.(Table.3)

Table 3: TABLE DEPICTING COMPARISON OF CARDIAC PARAMETERS BETWEEN NORMAL BUFFALOES AND THOSE AFFECTED WITH DIAPHRAGMATIC HERNIA.

Parameters	Normal (n=15)	Diaphragmatic Hernia (n=15)
LVIDd (cm)	7.91±0.05 (7.21-8.16)	6.95±0.007** (6.91-7.00)
LVIDs (cm)	5.28±0.08 (5.04-6.51)	4.03±0.02** (3.90-4.17)
FS%	33.26±1.06 (20.22-36.92)	42.05±0.34* (40.20-44.13)
EDV (ml)	336.67±4.79 (273.01-360.17)	251.98±0.59** (248.07-255.43)
ESV(ml)	134.97±5.93 (120.45-216.75)	77.26±1.07** (65.91-77.26)
EF %	59.88±1.60 (49.82-64.95)	61.67±0.40 (69.51-74.03)
SV (ml)	201.69±6.26	180.58±0.98**

	(143.42-223.20)	(174.13-187.87)
CO (lit/min)	12.46±0.28 (11.04-15.74)	8.32±0.03** (8.11-8.52)
CI (lit/m^2)	9.16±0.12 (8.55-10.12)	6.47±0.04 (5.79-6.47)
IVSd (cm)	1.95±0.03 (1.54-2.07)	1.73±0.03 (1.53-1.97)
IVSs (cm)	2.69±0.04 (2.21-2.95)	2.68±0.02 (2.52-2.84)
LVPWd (cm)	1.65±0.03 (1.43-1.98)	1.57±0.01 (1.51-1.65)
LVPWs (cm)	2.71±0.05 (2.32-3.20)	2.67±0.02 (2.38-2.80)
RVIDd (cm)	2.47±0.04 (2.20-2.76)	2.33±0.03 (2.21-2.77)
EPSS (cm)	0.72±0.01 (0.62-0.74)	0.71±0.00 (0.62-0.69)

NS $p \geq 0.05$, *$p < 0.05$, **$p < 0.01$

Cardiac compression can be induced by the diaphragmatic hernia in buffaloes leading to impaired cardiac function and reduced size of left ventricle during diastole. Left ventricle dysfunction and decreased cardiac output is associated with the diaphragmatic hernia in buffaloes. Changes in the dimensions of ventricles and poor left ventricular function were the main abnormalities found in M-mode echocardiographic studies in 40 bovine(Schober and Baade, 2000).

The findings of this study suggest that, the left heart compression might be an important contributor to small left ventricular volume and consequently reduced flow through the left heart in diaphragmatic hernia. The clinical presentation of diaphragmatic hernia induced cardiac compression can impair cardiac function and reduces the size of left ventricle during diastole significantly. Diaphragmatic hernia in cattle has ventricular dysfunction and decreased cardiac output (Hagio*et al.,* 1984).

M-mode and 2-dimensional echocardiography allow simple linear measurements of LV dimensions and wall thickness, and these measurements enable calculation of LV fraction shortening (FS), mass, and other cardiac parameters of systolic performance. There is limited data availability for the correlations between these parameters. Assessment of left ventricular function is extremely important. It correlates with symptoms, prognosis, events, and complications in a large number of conditions. Left ventricular function is usually established by computing or estimating ejection fraction. When the function of the heart is impaired, less blood will be ejected and the ejection fraction will fall. Ejection fraction is also a function of ventricular size. When the ventricle size is reduced in diaphragmatic hernia (compressed be hernia content), a relatively increased ejection fraction was observed.

An increase in echocardiographic measurements was observed with increase in weight in small and large ponies and horses (Slater and Herrtage, 1995). Linear regression with body weight was observed for left ventricle internal diamension in Beagle dogs (Crippa et al, 1992). They also observed significant difference between sexes in left ventricular wall thickness in systole and diastole. The left ventricular internal diameter at the end diastole (LVIDd) (cm), measured in normal buffalo, correlated closely with the echocardiographicalmeasurements in buffalo affected with diaphragmatic hernia (Yamaga and Too,1986).

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Abbreviations

LV, left ventricle; RV, right ventricle; LA, left atrium; RA, right atrium.

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TABLES

FIGURES

Fig 3: Bar graph showing LVIDs (cm) (mean±SE) of normal buffaloes and those affected with DH

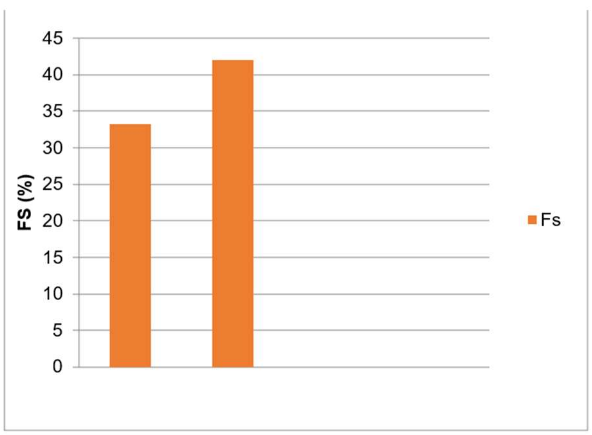

Fig 5: Bar graph showing FS (%) (mean±SE) of normal buffaloes and those affected with DH

Fig 4: Bar graph showing LVIDd(cm) (mean±SE) of normal buffaloes and those affected with DH

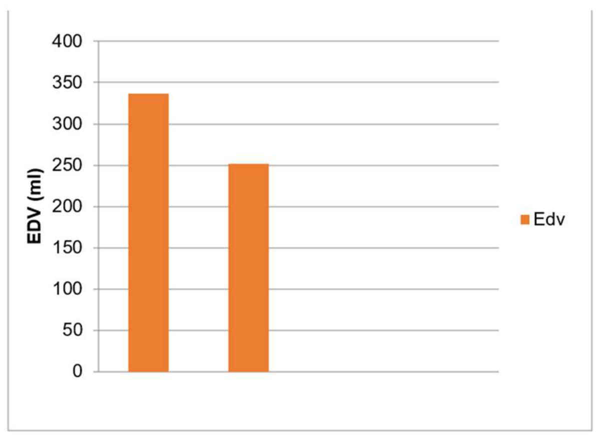

Fig 6: Bar graph showing EDV(ml) (mean±SE) of normal buffaloes and those affected with DH

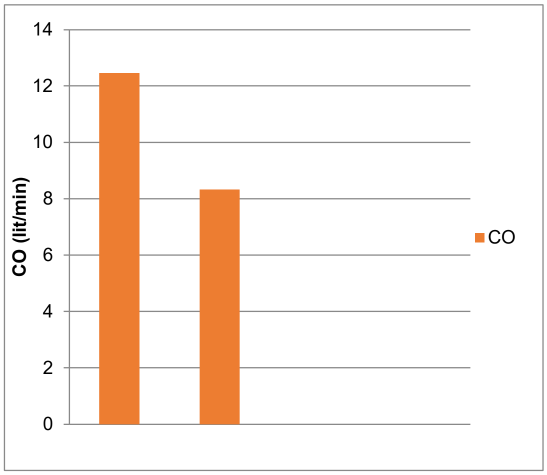

Fig 9: Bar graph showing CO(lit/min) (mean±SE) of normal buffaloes and those affected with DH