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Diagnostic evaluation of pericarditis in cattle

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Abstract

The study was carried out in 12 animals affected with pericarditis, showing clinical signs like jugular pulsations, jugular cording, oedema of brisket or submandibular region, muffled heart sounds and tachycardia. The mean age of animals affected was 6.33 ± 0.81 years, significant increase in rectal temperature, heart rate, respiratory rate and capillary refill time in affected animals. Haemato logically there was leucocytosis along with neutrophilia and lymphopenia, significant decrease in RBC, Hb and PCV indicating anaemia was recorded. Biochemically significant increase in ALT, AST, ALP, TP, globulins, creatinine and cTn - I concentrations and significant decrease in albumin, calcium and glucose in the cattle affected with pericarditis. Electrocardiography revealed normal sinus rhythm in 22.22%, low amplitude QRS complexes in 33.33%, ST-segment coving in 22.22%, prolonged ST-segment duration in 11.11%, and supraventricular tachycardia in 11.11% of the animals affected with pericarditis. Echocardiography revealed presence of pericardial effusions, accumulation of hypoechoic fluid and hyperechoic fibrin floating in the pericardial fluid. Radiographic examination of lateral thorax evidenced presence of foreign body beyond the diaphragm. Ultrasound guided pericardiocentesis revealed presence of pus or blood mixed pus on aspiration. Necropsy findings were presence of foreign body penetrating base of the heart, bread and butter appearance of the heart. Histopathological studies on the heart muscle found thickening of pericardium with infiltration of inflammatory cells and presence of parasitic micro cyst *i.e.*, *Sarcozystis* spp.

Keywords: Cardiac troponin - I, electrocardiography, echocardiography, radiography and histopathology

Introduction

Cardiac disorders in cattle have received little attention in the past. Most studies have dealt with specific forms of cardiac diseases and their clinical presentation (Buczinski *et al.*, 2006)^[5]. Although severe cardiovascular disease is relatively uncommon in bovines, it is important that the clinician examines this system with care during the routine clinical examination of the bovine patient. Early detection of cardiac disorder may enable appropriate remedial action to be taken and an accurate prognosis of the patient's condition to be offered.

Pericarditis is an inflammation of the pericardium, results in the accumulation of fluid or exudates between visceral and parietal pericardium (Reef and McGuirk, 2002)^[19], it occurs mainly due to perforation of infected foreign body into the pericardium or localization of a blood borne infection *viz.*, *Mannheimia haemolytic*, *Tuberculosis*, *Pseudomonas aeruginosa*, *Mycoplasma species* and sometimes non-septic form of pericarditis *i.e.*, idiopathic effusive pericarditis can also be seen (Radostits *et al.*, 2007)^[17]. Among these the most common disease of pericardium is traumatic pericarditis (Braun *et al.*, 2012)^[3], hardware with adequate length that penetrates the reticular wall in a cranial direction may perforate the diaphragm, pericardium and mediastinum. Both the foreign body and the tract of its migration contaminate the pericardial cavity, resulting in a fibrin us or purulent inflammation with severe exudation (Reef and McGuirk, 2009; Radostits *et al.*, 2007)^[20, 17]. The proximity of the reticulum to the pericardium appears to be primary cause of high occurrence of traumatic pericarditis in cattle and buffaloes (Singh *et al.*, 2019)^[25]. In cattle and buffaloes, pericarditis is characterized by clinical signs such as tachycardia, muffled heart sound, asynchronous heart sound such as rubbing or splashing sounds, jugular vein distension and oedema of the jaw, dewlap, ventral abdomen extending to udder, anorexia, decrease milk production, pyrexia, increased pulse rate, diarrhoea and scanty faeces are also observed. Congested mucous membrane and increased capillary refill time is also associated with pericarditis (Athar *et al.*, 2012; Braun *et al.*, 2012; Subramanian *et al.*, 2003)^[20, 3, 27]. There are three general forms of pericarditis, effusive, fibrinous and constrictive although combination of three can also occur.

Effusive pericarditis is characterized by accumulation of a protein rich fluid within the pericardial sac. Subsequent fibrin deposition will lead to fibrinous pericarditis and if fibrin within the pericardial sac matures to fibrinous tissue and fibrosis of the pericardium or epicardium then constrictive pericarditis will result (Perkins *et al.*, 2004) [15].

Materials and Methods

The study was conducted on 12 animals showing clinical signs of cardiac diseases presented to department of veterinary clinical complex veterinary college Bidar-KVAFSU, the mean age of the affected animals was 6.33 ± 0.81 years, six apparently healthy animals were selected for determining reference values, animals showing clinical signs such as presence of fever, jugular distention or cording, oedema of brisket or submandibular region, muffled heart sounds and tachycardia were selected for detailed evaluation and diagnostic techniques like haemato bio chemical analysis, electrocardiography, radiography, echocardiography, pericardiocentesis, necropsy and histopathological examination was conducted.

During clinical examination parameters like temperature, heart rate, respiratory rate and capillary refill time were recorded. 2ml of blood was collected in EDTA vial and complete blood count was carried out using fully automated haematology analyser (ERMA PCE 210® by AGD bio medicals private limited, Chennai-India) and 4ml of blood was collected in clot activated vial and serum parameters like ALT, AST, ALP, TP, albumin, calcium, glucose and creatinine was estimated using commercially available kits (ERBA Mannheim®) in semi-automated biochemical analyser (MICROLAB - 300®, Eli Tech Group).

Electrocardiography was carried out using base apex lead system in lead I were the positive electrode of lead I (left arm) was attached to the skin of the fifth intercostal space just caudal to olecranon and the negative electrode (right arm) on the jugular furrow about 1 / 3rd of the left side of the neck (Rezakhani *et al.*, 2004) [21] and lead II were the positive electrode (Left Leg) was placed on the skin over the left fifth intercostal space at the level of the elbow; the negative electrode (right arm) was placed on the skin over the right jugular furrow roughly 30 cm from the thoracic inlet and the ground electrode (left arm) was attached to the neck or withers (Peak and McGuirk, 2008) [14] using BPL™ (CARDIART 6108T® machine).

The cases suspected for foreign body syndrome were subjected to radiography for the visualization of potential foreign body which might be penetrating heart (ALLENGERS®, Allengers medical systems limited, Punjab - India). Lateral radiographs of heart, reticulum and chest were taken in left lateral recumbency or standing or supine position depending upon the state of the animal and the radiographic exposure factors used were 90-113 KVp, 50-70 mAs and 90-100 FFD (Sangwan *et al.*, 2018) [22].

Echocardiography was performed as described by Braun *et al.* (2001) [4] using portable ultrasound machine (CHISON®, China). In this study the probe used was 2.5-5 MHz convex abdominal probe. The animals suspected for pericarditis were prepared by shaving 25 x 25 cm area on left and right side from third to seventh intercostal space. Ultrasound gel was applied to make good contact with the surface, 2- D image was obtained.

Ultrasound guided pericardiocentesis was performed in animals detected with the pericardial effusion on

ultrasonography under local anaesthesia in the 3 - 4th intercostal space (ICS) at the level of olecranon process using 18 gauge, 3.5 cm long spinal needle and the samples collected in sterile syringes.

Necropsy was conducted in four animals which died during the treatment in the VCC. A thorough post-mortem examination was conducted, tissue samples were collected for histopathological examination.

All the data obtained were statistically analysed as described by Snedecor and Cochran (1994) [26]. The data were analysed by student t-test using SPSS software 20.0 (SPSS Inc. Chicago, IL, USA). Difference at $p \leq 0.05$ was considered statistically significant.

Results

The clinical signs in cattle affected with pericarditis were tachycardia, muffled heart sounds, jugular pulsations and cording, brisket and submandibular oedema was recorded. There was significant increase in rectal temperature, heart rate, respiratory rate and capillary refill time (table 1 and Figure 1 and 2).

Haematologically leucocytosis, decreased red blood cell count, haemoglobin and packed cell volume was seen indicating anaemia, the platelet count was within the normal range and differential leucocyte count revealed neutrophilia and lymphopenia were as the number of monocyte and eosinophils were not having any significant difference (Table 2).

Biochemically there was significant increase in the levels of ALT, AST, ALP, TP, globulins, creatinine and cardiac troponin-I (cTn - I) and significant decrease in levels of albumin, calcium and glucose (Table 3).

Electrocardiographic study was carried out in only 9 animals because of sudden death of the animals during presentation and ECG findings revealed normal sinus rhythm in 22.22%, low voltage QRS complexes in 33.33%, ST- segment coving in 22.22%, prolonged ST-segment duration in 11.11% and supraventricular tachycardia in 11.11% cattle (Figure 3, 4, 5, 6 and 7).

Echocardiographic examination of heart revealed presence of pericardial effusions, accumulation of pus and presence of hyperechoic fibrin strand floating in the pericardial fluid was seen (Figure 8, 9 and 10).

On radiographic examination of lateral thorax revealed presence of foreign body was recorded in eight animals and loss of thoracic details was recorded in four animals (Figure 11, 12 and 13).

Ultrasound guided pericardiocentesis was performed in five animals and found that the pericardial fluid was foul smelling and pus like in nature (2 animals) and bloody in nature in three animals. Based on these findings of pericardiocentesis, pericarditis was classified into Suppuration and haemorrhagic pericarditis (Figure 14).

Necropsy was conducted in four animals died during the course of treatment, presence of sharp penetrating foreign body was noticed in three animals (a wire and two sewing needles penetrating the base of heart was found), presence of large amount of fibrinous deposits between pericardium and epicardium giving bread and butter (constrictive pericarditis) appearance was noted in two animals (Figure 15 and 16).

Histopathological examination of heart tissue sample revealed thickening of pericardium with fibrin, haemorrhages between muscle fibres, accumulation of inflammatory exudates, degenerative and necrotic changes in the muscle

fibres of heart with the infiltration of inflammatory cells mainly neutrophils, lymphocytes and some monocytes were

noticed. (Figure 17, 18 and 19).

Table 1: Mean ± SE values of vital parameters in healthy and pericarditis affected cattle

Parameter	Healthy cattle	pericarditis affected cattle
Temperature (°F)	100.28±0.14 ^a	101.82±0.52 ^b
Heart rate (bpm)	75.33±2.81 ^a	102.66±4.33 ^b
Respiratory rate (breaths/min)	15.0±0.85 ^a	26.50±1.30 ^b
Capillary refill time (sec's)	2.33±0.42 ^a	5.25±0.50 ^b

Table 2: Mean ± SE values of haematological parameters in healthy and pericarditis affected cattle

Parameters	Healthy control	Pericarditis affected cattle
TLC (10 ³ /μL)	9.06±0.84 ^a	23.59±3.7 ^b
RBC (million/μL)	7.31±0.87 ^a	5.54±0.43 ^b
Hb (g/dL)	9.03±0.18 ^a	6.87±0.41 ^b
PCV (%)	36.70±4.65 ^a	25.95±2.05 ^b
PLT (x10 ³ /μL)	136.50±30.45 ^a	199.33±24.8 ^a
Neutrophil's (%)	39.33±1.80 ^a	70.75±3.87 ^b
Lymphocyte's (%)	60.00±1.73 ^a	26.66±4.27 ^b
Monocyte's (%)	0.66±0.33 ^a	1.0±0.34 ^a
Eosinophil's (%)	0.00±0.00 ^a	0.66±0.35 ^a

Table 3: Mean ± SE values of biochemical parameters in healthy and pericarditis affected cattle

Parameters	Healthy control	Pericarditis affected cattle
ALT (U/L)	30.58±1.52 ^a	59.99±5.15 ^b
AST (U/L)	46.35±4.46 ^a	183.39±41.97 ^b
ALP (U/L)	47.83±12.70 ^a	149.66±26.79 ^b
TP (g/dL)	9.36±0.81 ^a	11.83±0.22 ^b
Albumin (g/dL)	3.85±0.40 ^a	1.78±0.37 ^b
Globulin (g/dl)	5.80±0.80 ^a	10.13±0.36 ^b
Calcium (mg/dL)	10.10±0.67 ^a	6.55±0.16 ^b
Glucose (mg/dL)	64.90±1.61 ^a	32.90±4.44 ^b
Creatinine (mg/dL)	0.93±0.05 ^a	2.24±0.29 ^b
cTn-I (ng/dL)	0.29±0.08 ^a	0.75±0.11 ^b

Note: Mean ± SE values bearing different superscript differ significantly at ($p \leq 0.05$)



Fig 1: Brisket oedema and jugular cording in a cow affected with Pericarditis



Fig 2: Brisket oedema and submandibular oedema in a cow affected pericarditis

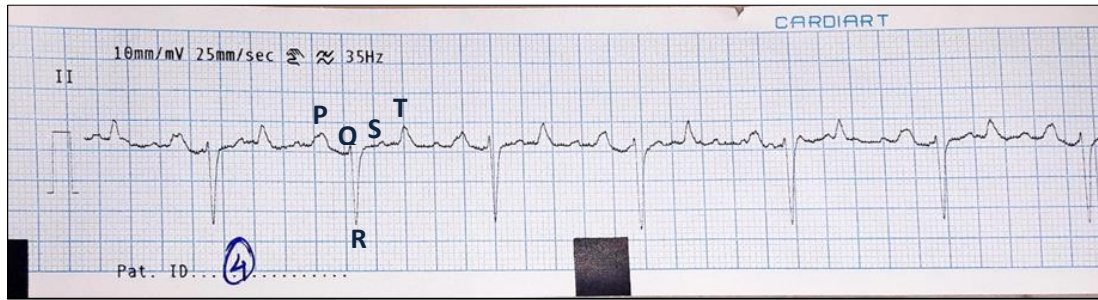


Fig 3: ECG of healthy cow (Lead II)

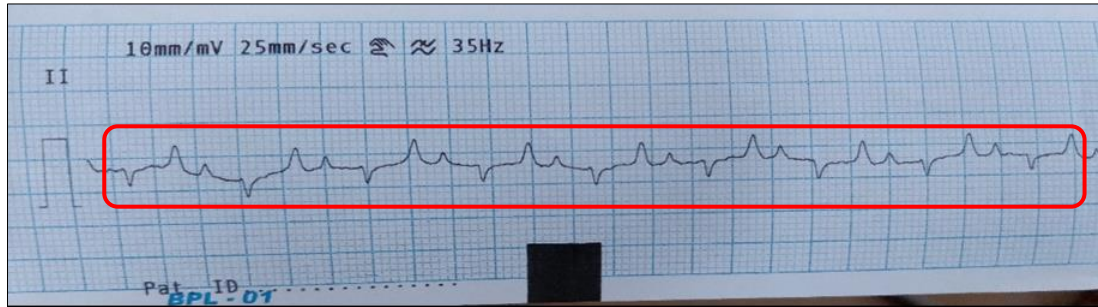


Fig 4: ECG showing low voltage QRS complexes in a cow affected with Pericarditis

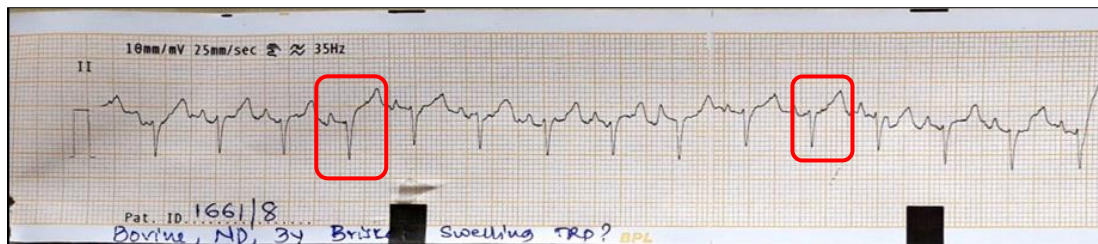


Fig 5: ECG showing ST segment coving in a cow affected pericarditis

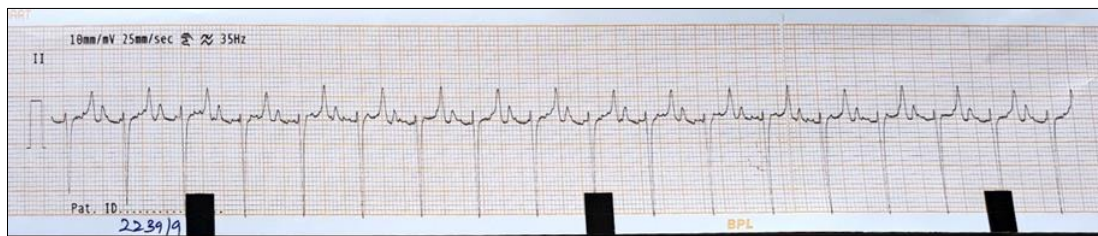


Fig 6: ECG showing supraventricular tachycardia in a cow affected pericarditis

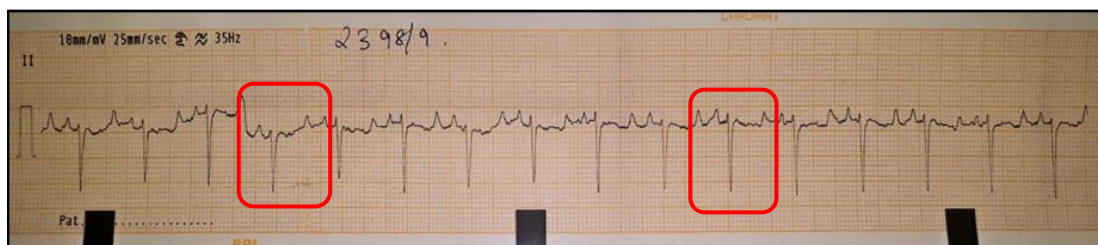


Fig 7: ECG showing prolonged ST segment duration in a cow affected pericarditis



Fig 8: Echocardiogram of a cow showed presence of homogenous pus between epicardium and pericardium suggesting Suppuration pericarditis



Fig 9: Echocardiogram of a cow showed presence of homogenous pus inside the pericardial space suggestive of Suppuration pericarditis



Fig 10: Echocardiogram of a cow showed fibrin floating in the pericardial fluid suggestive of fibrinous pericarditis

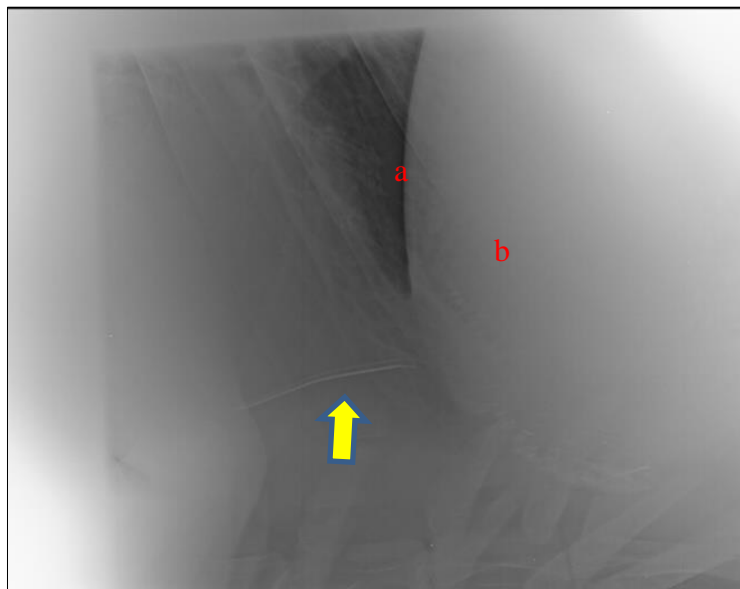


Fig 11: Lateral thoracic-abdominal radiograph showed presence of metallic foreign body inside thoracic cavity in a cow affected with pericarditis a) Diaphragm b) Reticulum

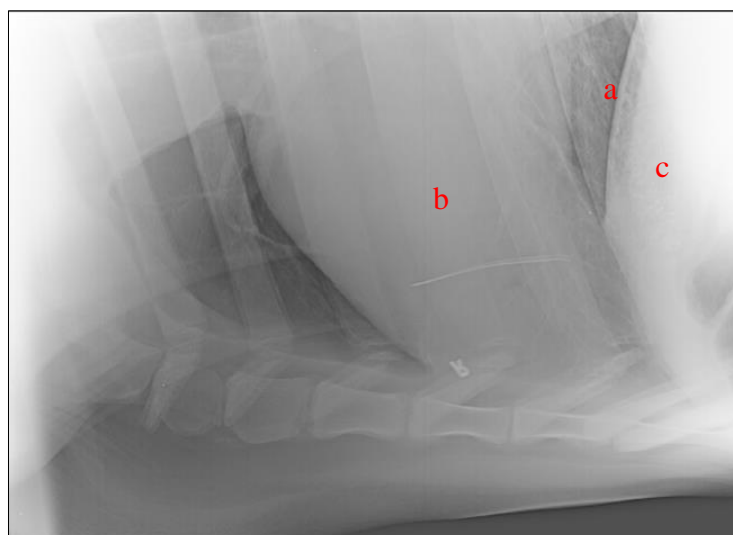


Fig 12: Lateral thoracic radiograph of a cow in supine position showed presence of sewing needle in the mediastinum a) Diaphragm b) Heart and c) Reticulum



Fig 13: Lateral thoracic radiograph of a cow affected with pericarditis showing loss of thoracic details



Fig 14: Pericardiocentesis at 5th ICS and on aspiration showed pus suggestive of Suppuration pericarditis in a cow

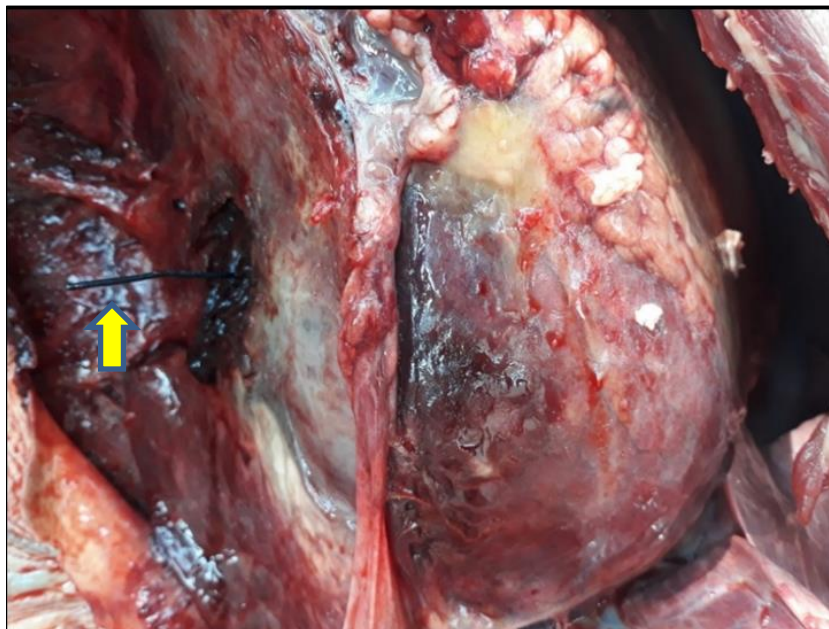


Fig 15: Post mortem image showing penetrating foreign body in the heart



Fig16: Wire collected from the heart of the animal on PM-examination

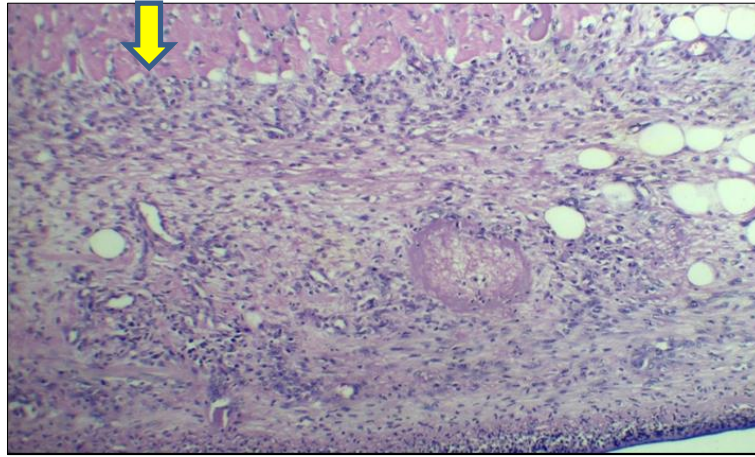


Fig 17: Histopathology of cardiac tissue showing accumulation of fibrin with thickening of pericardium and presence of bacterial colonies along with infiltration of inflammatory cells (100X)

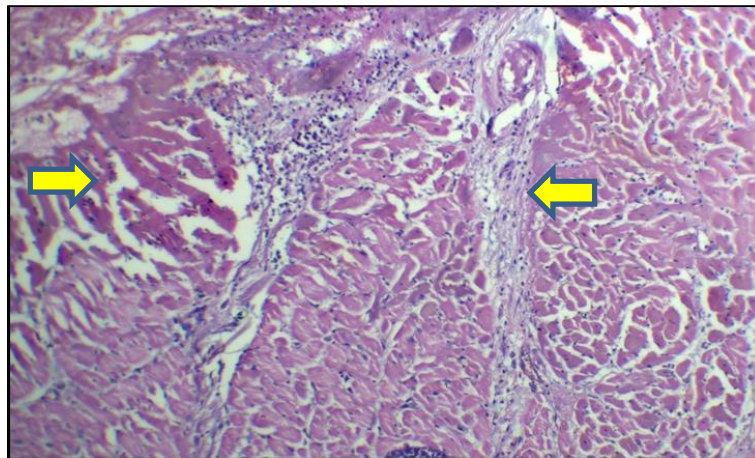


Fig 18: Histopathology of cardiac tissue showing degeneration, necrosis, inflammatory cellular infiltration and separation of muscle fibres (100X)

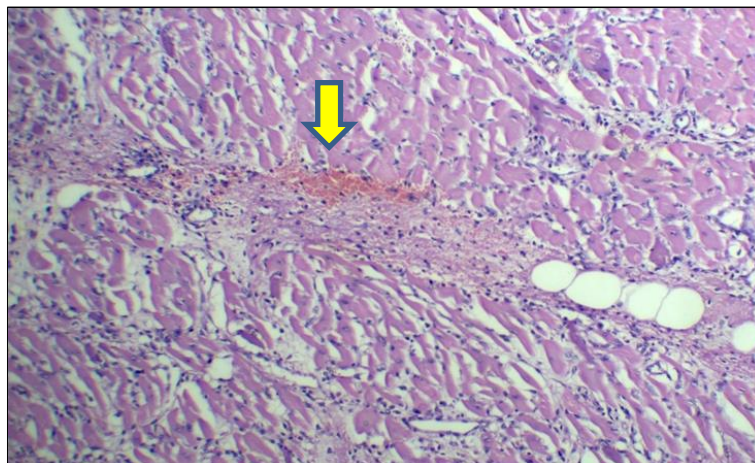


Fig 19: Histopathology of cardiac tissue showing haemorrhages and inflammatory cellular infiltration in between muscle fibres (100X)

Discussion

Pericarditis is characterized by presence of fever, drop in milk production, anorexia, jugular pulsations, jugular cording, oedema brisket and submandibular region, tachycardia, muffled and friction rub sounds on auscultation similar clinical findings were recorded by Manjunatha *et al.* (2016) [12].

Haematology revealed leucocytosis, neutrophilia and lymphopenia the results were in accordance with Gavali *et al.* (2003) [7], Ghanem, (2010) [8]. Leucocytosis and neutrophilia

might be attributed to severe inflammatory response to the invading pathogen. Erythrocytopenia, decreased haemoglobin and PCV was seen in animals affected with pericarditis indicating anaemia similar findings were recorded by Gavali *et al.* (2003) [7], Ghanem, (2010) [8] and Venkatesan *et al.* (2020) [30]. The anaemia might be due to haemorrhages caused by perforating foreign body and chronic nature of the disease. Serum biochemistry revealed increase in the levels of ALT, AST and ALP was seen this is in concurrent with Gavali *et al.* (2003) [7], Ghanem, (2010) [8], Simon *et al.* (2010) [24] and

Ramin *et al.* (2011) [18]. This could be attributed to impaired hepatic function as a consequence of hepatic damage by accumulated toxins. Increased concentrations of total protein and globulins were recorded in the affected group, these findings were in agreement with Tharwat (2010) [28], Ramin *et al.* (2011) [18] and Athar *et al.* (2011) [1]. The hyperproteinemia may be due inflammatory changes in the body and activation of immune response of host following infection. Hypoalbuminemia was recorded in pericarditis affected cattle similar results were recorded by Venkatesan *et al.* (2020) [30]. This could be attributed to hepatic dysfunction leading to reduced albumin synthesis. Increased concentration of serum creatinine was recorded in the affected group this is in accordance with Ghanem, (2010) and Venkatesan *et al.* (2020) [30]. This might be attributed to reduced renal blood flow, reduction in the glomerular filtration. Hypoglycaemia was found in cattle affected with pericarditis similar findings were recorded by Ghanem (2010) [8] and Ramin *et al.* (2011). The hypoglycaemia might be attributed to anorexia and subsequent hepatic damage. Hypocalcaemia was recorded in this study this is in agreement with Ghanem (2010) [8] and Ramin *et al.* (2011) [18]. The hypocalcaemia could be attributed to reduced calcium uptake as a result of anorexia. Significant increase in the concentration of cTn-I was seen in cattle affected with pericarditis this is in correlation with Gunes *et al.* (2008) [9], Fawzy *et al.* (2017) [6] and Venkatesan *et al.* (2020) [30]. Increase in the cardiac troponin-I might be attributed to myocardial damage.

Electrocardiographic evaluation revealed low voltage QRS complexes in pericarditis affected cattle these findings were in correlation with Tharwat (2011) [28], Puri (2016) [16], Joseph *et al.* (2018) [11] and Vershney (2020) [29]. The low voltage QRS complexes in ECG might be due to pericardial effusion leading to cardiac tamponade with inflammation and thickening of pericardium, however peripheral oedema leading to hypovolaemia may also cause low amplitude QRS complexes. The coving or elevation of ST segment was observed in pericarditis affected cattle the results were in concurrent with Radostits *et al.* (2007) [17], and Joseph *et al.* (2018) [11]. This might be due to electrolyte imbalances like hyperkalaemia and associated with myocardial hypoxia or cardiac hypertrophy. Supraventricular tachycardia noticed in pericarditis affected cattle. Supraventricular tachycardia might be due to discharge rate of irritant focus far exceeds that of the sinoatrial pacemaker resulting in tachycardia (Radostits *et al.*, 2007) [17].

Echocardiography revealed anechoic fluid in the pericardium and hyperechoic fibrin threads were imaged in cattle, the distinctively developed pus pockets and thickening of pericardium were suggestive of pericarditis. Similar observations made by Ghanem (2010) [8], Athar *et al.* (2011) [1]. Ultrasound guided pericardiocentesis was employed in this study in which the aspirated fluid contained foul smelling pus and blood mixed with pus were observed similar observations were noticed by Puri (2016) [16], Saravanan *et al.* (2018) [23] and Manjunatha *et al.* (2020) [13].

Radiological imaging showed unclear cardiac silhouette, distinct diaphragm, presence of potential penetrating foreign body, gas opacities were observed and were tentatively diagnosed as pericarditis. Similar findings were suggested by Athar *et al.* (2011) [1], Joseph *et al.* (2018) [11] and Sangwan *et al.* (2018) [22].

Post mortem examination revealed potential penetrating foreign body penetrating from the reticulum to base of the

heart along with fibrin purulent changes in the pericardium. Similar results were recorded by Ghanem (2010) [8] and Sangwan *et al.* (2018) [22].

The histopathology of cardiac tissue revealed the presence thickening of pericardium because of accumulation of inflammatory exudates, degenerative and necrotic changes and also extending to the myocardium of heart with the haemorrhagic streaks, and infiltration of inflammatory cells mainly neutrophils and monocytes were recorded. Present findings were in accordance with Ghanem (2010) [8] and Habasha and Yassein (2014) [10].

Conclusion

Based on these diagnostic modalities it is concluded that more than one diagnostic modality is needed for the diagnosis of pericarditis in cattle.

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