# ECHOCARDIOGRAPHY AND ENDOCARDITIS DIAGNOSIS AMONG DAIRY COWS

By

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## SUMMARY

***Clinical examination with laboratory investigation were recorded in three Holstein Frisian cows in private farms in Hokkaido, Japan. All cows showed fever, depilation, decrease in milk production and general weakness with loses of body condition. The primary diagnosis was mastitis in two cases and pneumonia in last one. Blood picture results revealed overall leucocytosis, with increase segmented white blood cell percentage beside hypoplastic anemia. Biochemical alterations were hyperprotenaemia, hypoalbumenaemia and hyperglobulinaemia with decrease of A/G ratio in endocarditic cows beside abnormal hepatic function in one case and hypocalcemia in anther one. Fluoroscopy X ray and electrocardiograms showed patches of pneumonia in one case and dilated caudal vena cava in anther case with abnormal ECG traces in two cases only, respectively. Confirmatory diagnosis was recorded by using echocardiographic images of heart endocardium that shows vegetation in tricuspid valves in all cases and in mitrial valve in one case. The echocardiographic finding was the only confirmatory diagnostic tool of endocarditis.***

## INTRODUCTION

Cardiac diseases among cattle are variables. The often-un/misdiagnosed important one of them is endocarditis (Evans 1957). Endocarditis is a relatively common, it is a chronic inflammation of the endocardium, and usually limited to the cardiac valves but may extend over or else primarily involve the mural endocardium. The disease is caused commonly by bacterial invasion to endocardium of the heart frequently preceded by systemic infection (Evans 1957 Pipers et al 1978 Robinson and Maxie 1983). Damaging of valvular leaflet endothelium are

predisposing cattle to bacterial endocarditis that caused by chronic mastitis, chronic metritis, and/or traumatic reticuloperitonitis lead to chronic bacteremia. (Evans 1957 Power and Rebhum1983 Cabana et al 1990 Houe et al 1993 Patricia and Jeff 1994). Among cattle, the right side of the heart is usually affected and the tricuspid valve function is often compromised due to vegetation on the valve leaflets (Evans 1957 Lacuata et al 1980). In the colder part of Japan, in Hokkaido, endocarditis is a major disease of dairy cattle, causing great financial losses. The endocarditis clinical signs are varied, numerous and non- pathognomic (Lacuata et al 1980).

The clinical signs are not pathognomic to endocarditis and may observed in many common diseases (Patricia and Jeff 1994). These signs include unexplained constant or intermittent fever, dyspnea, cough, pale mucose membrane, anorexia, lose of condition, diarrhea and decrease of milk production (Rao and Kamalapur 1975 McGurik et al 1990). Rumen contractions were detected or not at two minutes intervals with poor appetite. In sever and chronic endocarditic cattle often have clinical signs of right-sided heart failure that includes tachycardia, pounding heartbeat, jugular and mammary vein distention with palpable irregular pulses, ventral edema, weight loss and poor production (Power and Rebhum1983 Tyler et al 1991 Patricia and Jeff 1994). The clinical pathology associated with bacterial endocarditid was leukocytosis, neutrophilia, hyperfibeinogenemia, and anemia in chronic cases (Evans 1957 Rao and Kamalapur 1975 Power and Rebhum 1983 Cabana et al 1990).

Hypocalcaemia, hyperphosphatemia, hyperproteinamia and hypoalbuminemia increased activities of L-iditol dehydrogenase,γ-glutamyltransferase, and asparatate transaminase (Tyler et al 1991).

The biochemical results are also not specific because similar alterations might observe in many other chronic inflammatory diseases (Patricia and Jeff 1994). Furthermore it was investigated whether the glutaraldehyde coagulation time test, which can detect high immunoglobulin concentrations, is almost invariably positive in bacterial endocarditis (Houe et al 1993). The diagnosis of endocarditis has traditionally been based on clinical examination and blood culture. These ways may leads to either false positive or negative diagnosis that finally causes later diagnosis and poor prognosis.

Electrocardiography has a limited value in the diagnosis of bacterial endocarditis among cattle due to extensive Purkinje

system results in simultaneous, rather than sequential, depolarization of the myocardium, but it is noted that the disease is usually associated with sinus tachycardia (Hamlin and Smith 1970 Lacuata et al 1980).

A noninvasive device employing pulsed ultrasound has been used in cardiology diagnosis (Joyner et al 1967 Freigenbaum 1972). Application of ultrasound imaging is the single most important advancement in clinical diagnosis of cattle endocarditis. Echocardiography is less sensitive but more specific, than blood culturing in diagnosis of cattle endocarditis (Pipers and Hamlin 1977 Dennis et al 1978 Bonagura and Pipers 1983 Ware et al 1986). Patricia and Jeff (1994) reported that ultrasongraphic imaging of a valvular lesion in cattle with a history of recurrent fever are definitive clinical diagnosis of bacterial endocarditis.

Single dimensional ultrasonography has been used to image cardiac vegetations in cow (Pipers et al 1978 Lacuata et al 1980). The aim of present study is to record the most predisposing infection among dairy cows endocarditis, to describe clinical sings and body condition score among cattle suffered from endocarditis, to apply of electrocardiogram and finally echocardiogram and devices as diagnostic aids.

## MATERIALS AND METHODS

The investigated animals were from different private farm in Hokkaido, Japan. The past history of two of these cases was mastitis. The preliminary diagnosis of these cases either mastitis or pneumonia.

History of the cases: Patient ages were ranged between 3 to 8 years old Holstein Frisian cows which developed illness five to eight months post calving. The previous symptoms were recurrent fever associated with concurrent anorexia with decrease in body weight and reduced of milk production. The appetite was variable, the diseased cow looks weak and emaciated. Two cases received antibiotic for their treatment, the fever was subsided and then retain to rise after time. Blood samples were collected to record complete blood picture and blood serum samples were used to investigate the biochemical profile of these animals as an aid in the primary diagnosis.

Table 1 summarized the past history and owners complain among examined diseased cows.

| Case number / Criteria | Case 1 | Case 2 | Case 3 |
|---|---|---|---|
| **Age / years** | 8 | 3 | 2 |
| **Last parturition / month** | 8 | 7 | 5 |
| **Owner complain:** | | | |
| ● **Decrease of milk production.** | +ve | +ve | + ve |
| ● **Lethargy.** | +ve | +ve | +ve |
| ● **Change in milk constituents.** | +ve | +ve | -ve |
| ● **Fever** | +ve | +ve | +ve |
| ● **Swollen of joints of 4 legs.** | -ve | -ve | +ve |
| ● **Appetite** | Anorexia | Anorexia | Poor |

## General Physical examination:

A complete clinical examination was conducted in the investigated cows. Fluoroscopy X-ray examination was applied by using 300-kVp, 7-mA fluoroscopic machine (Japan made). Cardimax FX- 324 electrocardiogram (Japan made) was used by applying base- apex lead electrocardiogram; at paper speeds of 25 and 50 mm/sec. Trace of lead II (aVL) was recorded. B- mode bright echocardiogram was performed by using EUB- 415 ultrasound scanner (Japan made). Low frequency transducers (3.5- MHz) was used for an adequate penetration of bovine chest. The sector scanhead transducer should be directed between costal margins, providing long- axis views of the heart. The scanner was directed between costal margins and allows more complete imaging of all four chambers and valves (Bonagura et al 1985). The transducer placed in the right parasternal position to determine the aortic, mitrial and tricuspid valves. When it covert to left parasternal position, to determine pulmonic valve. The echocardiograms were obtained in standing position without anesthesia, using an ultrasound module with continuous recording capability. Ultrasonic coupling gel was used to couple a handheld 13 mm- diameter, 3.5- MHz with medium focus transducer.

Glutaraldehyde coagulation test: This test applied on case 3 and compared by three clinically endocarditis free cows. The reagent and the test were prepared and conducted, respectively after Houe, et al (1993)

Body condition score (BCS) was determined by using a 5-point scale (1= emaciated, 2= thin, 3= average, 4= fat and 5= obese), with an increment of 0.25 for BCS between 2.0 and 4.0 (Ferguson et al 1994)

## RESULTS

Fever, tachycardia, mild in appetence and moderate reduction of milk production were the main clinical sings of three cases.

The clinical examination of the diseased animals revealed elevated arrythmic pulse rate with respiratory rate. The mummers systolic heart sound was audible in case 2 only with loud and irregular pulsation in all examined cows. Case 2-showed pale mucose membrane and muscular fibrillation above the cardiac area. Case 1 showed slight jugular vein distention and there is resistance during intravenous injection due to increased the venous pressure. Chest auscultation revealed slight exaggeration sound with audible of heartbeats over the chest in case 3. The udder was swollen, hard and applied modified California mastitis test indicates +++ (case 1 and case 2). All affected cows showed body condition score 1. Table 2 summarized the physical examination among the affected cows.

**Glutaraldehyde coagulation test**

The timing of positive coagulation among animals with endocarditis was done in case 3 and takes 30 seconds while in control negative cows (number is 3) it was 4 ± 1 minute.

Table 2 summarized of the physical examination among endocarditic cows

Table 3 showed overall leucocytosis, with increase segmented white blood cell percentage in diseased cows if compared by normal reference range. Case 2 showed high fibrinogen level than the normal reference range. In Case 2 and 3 recorded decrease in both values of MCV and MCHC compared by normal references range. Table 4 declared hyperprotenaemia, hypoalbumenaemia and hyperglobulinaemia with decrease of A/G ratio in all endocarditic cows. Hypocalcaemia in case 2 and abnormal hepatic function test in case 3 represented by high level of AST and LD activities than normal range with high level of total biliuribe were recorded in table 4.

Fluoroscopy images showed dilation and dens of caudal vena cava in case 1 (Fig 1) and patches of pneumonia in case 3 (Fig. 6). The ECG traces showed elongated QRS wave in both case 1 and 3 (Fig. 3 and 9) with elongated T wave in former case (Fig. 3). Case 2 showed normal ECG trace (Fig 5) at speed paper

25-mm/ sec. (10 mm= 1mV). Ultrasound image of liver in case 3 showed hepatic interlobular cellular infiltration (Fig 7). B- mode echocardiogram demonstrated marked thickening of tricuspid valve, appear as irregular echoes with different diameter and different degrees of blocking in all cases (Fig. 2, 4, 8). Case 2 showed also beside tricuspid valve vegetation a mitrial valve visitation (Fig. 4)

## DISCUSSION

In domestic animals including cattle, the heart valves are commonly supplied by blood vessels. The pathogenesis of the endocarditis is attributed to one of the three mechanisms- implantation of bacteria into the valves via the bloodstream, bacterial embolism in the valve capillaries, or edema of the valve following myocarditis with secondary endothelial damage (Shouse and Meier 1956).

The clinical diagnosis of endocarditis is difficult because non-specific clinical signs often accompany the disease condition and it is often misdiagnosed (Evans 1957 Roussel and Kasari 1989).
A careful history and attended clinical examination might consider the diagnostic keys of bacterial endocarditis. A primary infection focus as chronic mastitis, metritis, traumatic reticuloperitonitis and muscloskeletal abscessation or cellulites or lesions in galls are potential sources of bacteremia and considered a predisposing causes infection to the endocardium (Power and Rebhum1983 Houe et al 1993). Endocarditis not always accompanied by a history of associated chronic infection such as arthritis, metritis or mastitis (Power and Rebhum1983). The same finding was obtained by our cases history that the case 1 and 2 had mastitis and the third one has no history of member previous infection.
The clinical sings among diseased cows were fever, mild inappetence and moderate reduction of milk production with elevated arrythmic pulse rate with respiratory rate. The same clinical singes were reported by (Cabana et al 1990 Patricia and Jeff 1994).

The clinical diagnosis of cattle endocarditis include tacycardia, might systolic heart murmur due to valvular insufficiency or stenosis (case 2), these signs may not developed concurrently in all cases. Heart murmur in cattle is not necessarily found in association with endocarditis (case 1 and 3) the same

result was previously obtained (Evans 1957 Pipers et al 1978). The absence of murmur heart sound might be as a clinical fact or might reflect the veterinarian inability to auscultate a slight murmur due to the chest wall thickness of the cattle, also the tendency for cattle to have three heart sound or gallop rhythm may interfere with the clinician's ability to hear the murmur in case of bacterial endocarditis (Power and Rebhum1983). All affected animals had body score 1 this reflect lose of condition and anorexia that animals were suffered from.

The haemogram picture (table 3), leucocytosis was observed allover the diseased cows this increasing in white blood cells might attributed to neutrophilia which associated with infection conditions and inflammation. The same result is agreed with Cabana et al (1990) and Dowling and Tyler (1994) and disagreed with Evans (1957). Mild hypoplastic anemia was recorded in both case 2 and 3 with decrease values of MCV and MCHC compared by normal references range, this anemia represented clinically by pale mucose membrane in case 2. Anemia associated with endocarditis was recorded previously (Evans 1957 Power and Rebhum1983 Cabana et al 1990 Tyler, et al 1991). Biochemical alterations associated with the diseased cows (table 4) were hyperproteineamia and hypoalbuminaemia and hyperglobunaemia. Increased serum protein retained to high level of serum globulins that indicated bacterial infection among diseased cows. Hypoalbuminaemia was attributed to anorexia that diseased animals were suffered from; same finding was obtained by Tyler, et al (1991). Case 2-showed increased fibrinogen level than the reference normal range, this high level might be attributed to bacterial infection associated with diseased cows, The same finding was obtained by Cabana et al (1990). Hypocalcaemia was recorded in case 2 (table 4) this result explain the muscular fibrillation of this cow. Hypocalcaemia among endocarditic was also recorded by (Tyler, et al 1991). Elevated serum ALT and LD activities beside high total bilirubin concentration in case 3 represent abnormal liver function test among this case, this might attributed to hepatic venous congestion or to hepatic cellular infiltration. The same result and attribution was mentioned by (Tyler, et al 1991).

Glutaraldehyde coagulation test was applied on case 3-blood sample. The timing of positive coagulation was < 1 minute while in three control negative cows it was 4 ± 1 minute. The rapid positive

coagulation glutaraldehyde test in chronic infection with endocarditis was attributed to high immunoglobulin concentrations. Same result and attribution were obtained by Houe et al (1993).

Electrocardiograph traces showed aggravated QRS wave in both case 1 and 3 (Fig 3,9) that indicated tricusped valve stenosis and elongated T wave that indicate potassium retention and hypoxia in case 1 (Fig 3). These findings were not diagnostic of endocarditis. The same result was obtained by (Lacuata et al 1980).

ECG examination revealed no trace abnormalities in case 2 (Fig 5). The same finding was obtained by (Cabana et al 1990 Tyler, et al 1991 Houe et al 1993). This condition might be attributed to cardiac depolarization pattern in cattle does not produce a major vector. Consequently changes in chamber size will often remain occult on ECG (Lacuata et al 1980).

Ancillary aid for diagnosis include echocardiographic. Vegetations appear as echogenic shaggy or cystic masses of various sizes (Fig.2, 4, 8). The same finding was obtained by Yamaga and Too (1986). The main affected valve in the three cases was tricuspid valve; the same observation was obtained (Pipers et al 1978 Power and Rebhum 1983 Dowling and Tyler 1994).

**Conclusion**

The diagnosis of endocarditis in cattle can be based initially on previous infection history especially mastitis, intermittent fever, depletion and loss of body condition score history, symptoms, physical findings and application of glutaraldehyde coagulation test. Endocarditic cows have body condition score (BCS) 1. The result of using electrocardiography is variable and not diagnostic in some cases. Additional confirmatory valuable diagnostic and prognostic information can be gained through evaluation of heart and its valves functions by using echocardiography. Endocarditis probably would not have been diagnosed before death without the aid of echocardiography because the reflected echoes from the vegetations, whether mural or valvular, are clear.

It should emphasized and announce that the local treatment of mastitis is not sufficient to prevent concurrent affection by endocarditis that is usually misdiagnose with indigestion, pneumonia, or other similar diseases that leads to same symptoms.

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**Table 2 summarized of the physical examination among endocarditic cows**

| Clinical examination | Case 1 | Case 2 | Case 3 |
|---|---|---|---|
| Body temperature | 41.4 | 39.7 | 39.5 |
| Pulse rate/ minute | 122 | 100 | 120 |
| Pulse quality | Weak | Weak | Weak |
| Pulse rhythm | Irregular | Irregular | Irregular |
| Respiratory rate | Increased | Increased in rate | High |
| Rumination | ± | No | + |
| Ruminal movement/ 2 minute | 2 incomplete | Sluggish | 1 |
| Muscular fibrillation above the cardiac area | - ve | + ve | -ve |
| Ping test | - ve | - ve | -ve |
| Heart sound | Loud, muffled and separated. Finally the murmursound audible. | Weak, with abnormal audible noise. Mummers systolic heart sound | Loud sound with irregular rhythm |
| Jugular pulsation | + ve. | -ve | -ve |
| Others | Modified California mastitis test is + ve. Swollen and hard udder. Flacks in milk. | Flacks in milk with changed color and taste. | -ve |
| First diagnosis | Acute mastitis. | Acute mastitis | Pneumonia |
| First treatment | From one month by Penicillin therapy. | From ten days by Pencilline therapy. | No |
| Udder | Swelling, and hard | Swelling, and hard | Normal |

Table 3: Hematological picture among endocarditic cows

| Animals / Criteria | Case 1 | Case 2 | Case 3 | Overall mean ± Stander Error | References normal range Radostits et al (1997) |
|---|---|---|---|---|---|
| RBCs $10^6$/ ul | 551 | 687 | 753 | 663.7 ± 48.5 | 488 - 744 |
| HB gm/dl | 9.4 | 10.7 | 9.2 | 9.77 ± 0.4 | 8 - 13 |
| PCV% | 27.2 | 31.6 | 28.7 | 29.2 ±1.1 | 24 - 36.7 |
| MCV fl | 49.4 | 46 | 38.1 | 44.5 ±2.7 | 41.6 - 57.4 |
| MCH pg | 17.1 | 15.6 | 12.2* | 14.96 ±1.2** | 15.1 - 20.4 |
| MCHC g/dl | 34.6 | 33.9 | 32. 1* | 33.5 ±0.6** | 33.9- 37.8 |
| WBCs $10^3$/ ul | 61 | 111 | 138 | 103.3 ±18.5** | 44 - 101 |
| Stab form leucocyte % | 3.0 | 0.0 | 0.0 | 1 ± 0.8 | 0 - 2 |
| Segmented % | 39 | 67 | 60 | 55.3 ± 6.9** | 25 - 45 |
| Eosinophilies % | 3.0 | 2.0 | 1.0 | 2 ±0.5 | 0 - 10 |
| Monocytes % | 5.0 | 4.4 | 8.0 | 5.8 ±0.9 | 2 - 8 |
| Lymphocytes % | 50 | 27 | 31 | 36 ±5.8 | 45 - 55 |

**Overall mean higher than the normal reference range.

*Individual level higher than the normal reference range. --- Not estimated.

Table 4: Biochemical profiles among endocarditic cows

| Animals / Criteria | Case 1 | Case 2 | Case 3 | Overall mean ± Stander Error | References normal range Radostits et al (1997) |
|---|---|---|---|---|---|
| Total protein g/dl | 7.7 | 11.1 | 9.5 | 9.4 ±0.8** | 5.6 - 8.7 |
| Albumen % | 31.3 | 16.3 | 18.4 | 22 ±3.8## | 42.4 - 61.1 |
| α- globulin % | 10.7 | 16.1 | 17.5 | 14.8 ±1.7** | 7.9 - 11.5 |
| β- globulin % | 8.1 | 5.9 | 8.0 | 7.3 ±0.6** | 6.6 - 9.7 |
| γ- globulin % | 49.9 | 61.7 | 56.1 | 55.9 ±2.8** | 21.9 - 25.6 |
| A/G ratio | 0.46 | 0.19 | 0.23 | 0.29 ±0.1## | 0.79 - 1.21 |
| BUN mg/ dl | 19.7 | 15.4 | 23.2 | 19.4 ± 1.8 | 10 - 25 |
| Blood Glucose mg/ dl | 71* | 68 | --- | --- | 45 - 70 |
| CPK IU/L | 176 | 137 | --- | --- | 60 - 230 |
| AST IU/L | 73 | 77 | 169* | 106.3 ± 25.6** | 47 - 100 |
| γ- GTP IU/L | 27 | 34 | 21 | 27.33 ± 3.1 | 13 - 35 |
| Total billiuribine mg/ dl | 0.2 | 0.19 | 0.4* | 0.26 ± 0.1 | 0.09 - 0.31 |
| LDH IU/L | 1590 | | 2808* | --- | 1500 - 2700 |
| Calcium mg/ dl | — | 8.1# | 8.5 | --- | 8.5 - 10.4 |

**Overall mean higher than the normal reference range. *Individual level higher than the normal reference range.

## Overall mean lower than the normal reference range. #Individual level lower than the normal reference range.

--- Not estimated.

Images of case 1

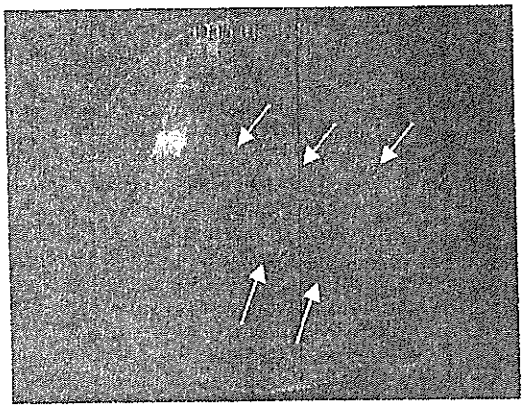

Fig 1. Fluoroscopy X ray showed dilated and dense caudal vena cava in endocarditic cow.

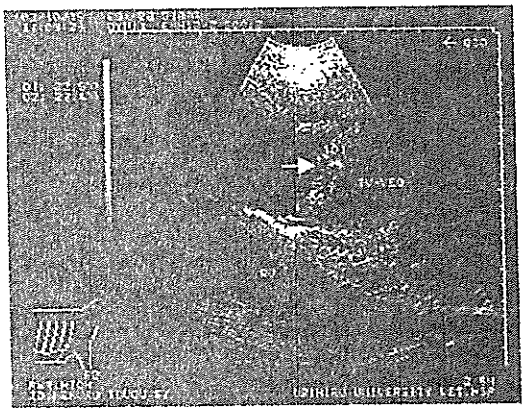

Fig 2. Tricuspid valve vegetation with 32.6 x 27.4 mm diameter with normal aortic valve.

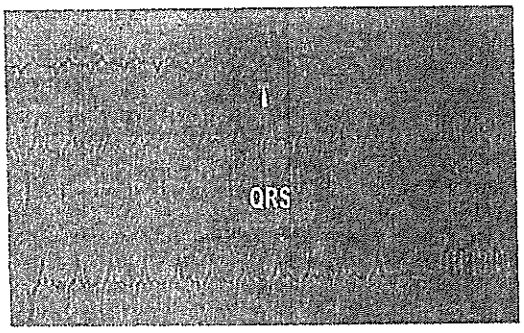


Fig 3. Elongated QRS wave indicated tricusped valve block and elongated T wave indicated hyperkalemia and anoxia at speed paper 25 mm/ sec. (10 mm= 1mV)

**Images of case 2**

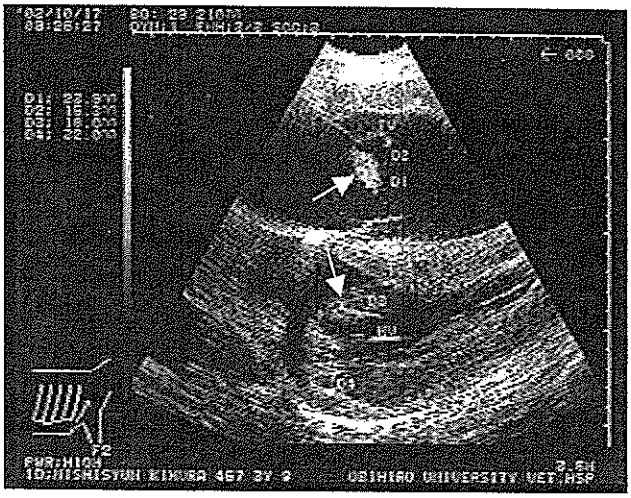

Fig 4. Tricuspid valve vegetation with 23.8 x 15.3 mm diameter with mitrial valve vegetation with diameter 18 x 32 mm

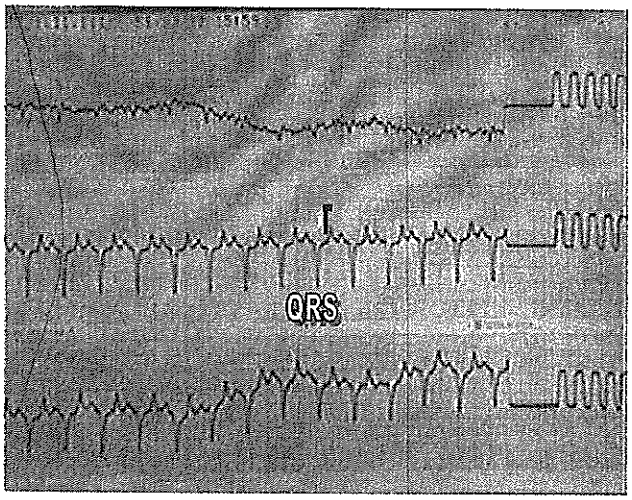


Fig 5. Normal ECG trace at paper speed 25 mm/ sec. (10 mm= 1mV)

**Images of case 3**

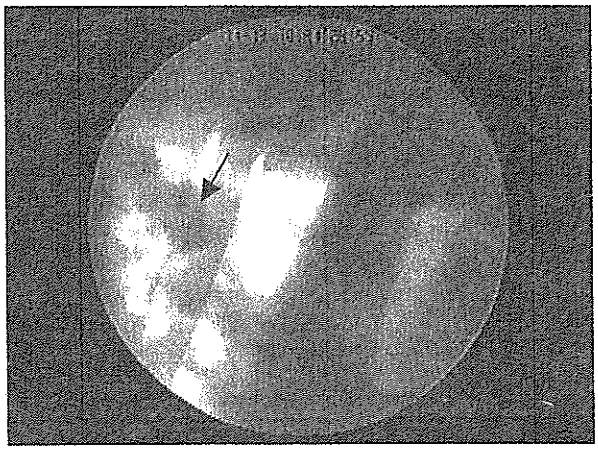

Fig 6. Fluoroscopy X ray showed patches of pneumonia in endocarditic cow lung.

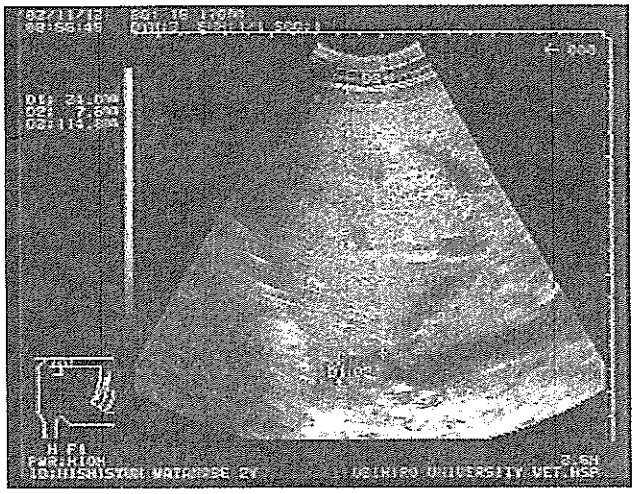

Fig 7. Ultrasongraphy of liver showed hepatic interlobular cellular infiltration in endocarditic cow.

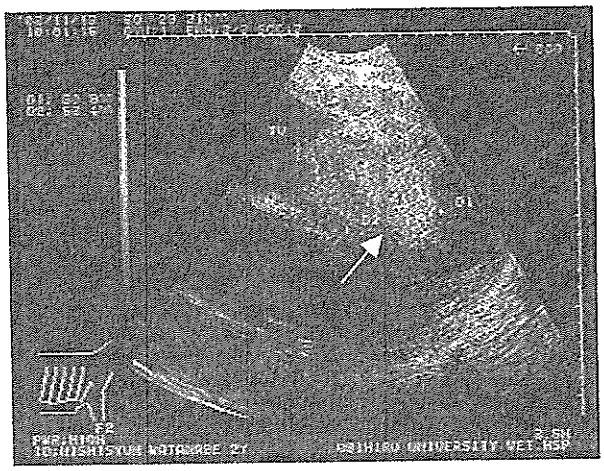

Fig 8. Large vegetation with diameter 80.9x 63.4 mm blocked the tricusped valve.

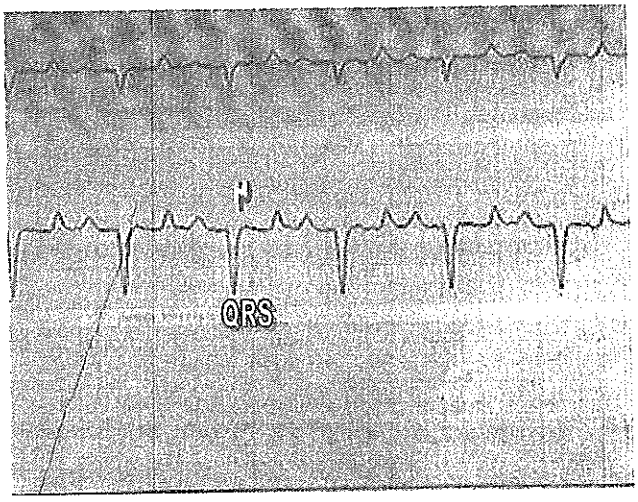


Fig 9.Elongated QRS wave indicated tricusped valve block at speed paper 25 mm/ sec.

(10 mm= 1mV)