Review Article

Canine Tuberculosis: A Review

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Abstract

Mycobacterium tuberculosis is one of a number of closely related intracellular bacterial pathogens, grouped together as the M. tuberculosiscomplex (MTC) which cause granulomatous disease in a broad range of host species. The genus Mycobacterium contains various obligate or opportunistic microorganisms. Mycobacterium tuberculosis, the primary agent of human tuberculosis (TB), is uncommonly isolated from cases of animal TB. However, natural infection by this pathogen can occur in a wide variety of animal hosts following close, prolonged contact with infectious humans. It is the principal cause of human tuberculosis and the extraordinary success of this pathogen is reflected by its distribution. Dogs infected with Mycobacterium tuberculosis can develop clinical tuberculosis (TB) but there are currently no validated immunological assays for diagnosing this infection in this species.TB is caused by bacteria of the Mycobacterium tuberculosis complex, mostly M. tuberculosis, but rarely also M. canetti, M. microti, M. africanum, and M. bovis. Mycobacteria are non-motile, non-spore-forming, aerobic, rod-shaped bacteria of 2–4 µm in length and possess a unique lipid-rich cell wall which gives the 'acid-fast' property by which they are known (acid-fast bacilli or AFBs) and renders them resistant to many disinfectants and antibiotics.Sometimes the infection doesn't cause any symptoms. This is known as latent TB.It's called active TB if one has symptoms. Most TB infected dogs do not have any signs, as the canine immune system actively suppresses the bacteria. When disease does occur common signs include weight loss, anorexia and harsh, non-productive coughing, depression, increased thirst and increased urination, diarrhea, jaundice (yellow tinge to the gums) and dehydration.

Key words: Anthropozoonosis, Acid- fast bacilli, Canine tuberculosis, PCR

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Introduction

Mycobacterium tuberculosis is one of a number of closely related intracellular bacterial pathogens, grouped together as the *M. tuberculosis*complex (MTC) which cause granulomatous disease in a broad range of host species (Dye *et al.* 1999). The genus *Mycobacterium* contains various obligate or opportunistic microorganisms. The latter are mostly members of the *Mycobacterium avium* complex, acquired mainly from environmental sources, for example, soil, water, dust, and feed. *M. avium* complex strains can cause disease in humans and in a wide range of animals, including dogs and cats, mainly in immunocompromised individuals (Asford*et al.* 2001). In general, infections with *M. avium* complex strains are rare in dogs (Campora*et al.* 2011), as these animals are considered less susceptible to infections with these organisms in comparison to those with *M. tuberculosis* (Thorel*et al.* 2001).Dogs infected with *Mycobacterium tuberculosis* can develop clinical tuberculosis (TB) but there are currently no validated immunological assays for diagnosing this infection in this species (Parsons *et al.* 2012).

Fig.1: The dog died due to *M. tuberculosis*

Typically, tuberculosis in dogs affects lungs and their regional lymph nodes (Szaluś-Jordanow *et al.* 2016). Experimentally, in most cases susceptibility of dogs to infection with *Mycobacterium tuberculosis* runs sub clinically with pathological changes localized mainly in lungs, lymph nodes, small intestine, kidneys, liver and spleen (Bonovska *et al.* 2005). *Mycobacterium tuberculosis*, the primary agent of human tuberculosis (TB), is uncommonly isolated from cases of animal TB. However, natural infection by this pathogen can occur in a wide variety of animal hosts following close, prolonged contact with infectious humans (Michel *et al.*, 2003). Companion animals (mainly dog) living in contact with TB patients are at great risk of exposure to this pathogen (Snider *et al.* 1971). It is the principal cause of human tuberculosis and the extraordinary success of this pathogen is reflected by its distribution (Dye *et al.* 1999). Despite the widespread occurrence of *M. tuberculosis*, infection by this organism is rarely diagnosed or maintained in

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free-living non-human hosts (Alexander *et al.* 2002). The precise nature of this apparent host-adaptation is unresolved, presumably involving aspects of both host physiology and ecology (Smith *et al.* 2006).

Etiology

Mycobacterium tuberculosis is the etiological agent of tuberculosis. Tuberculosis bacteria enter the body through the inhalation of infectious droplet nuclei. The lipoarabinomannan of the tuberculosis bacilli cell envelope bind to the mannose receptors of host macrophages (Dixit and Kotra, 2007). TB is caused by bacteria of the *Mycobacterium tuberculosis* complex, mostly *M. tuberculosis*, but rarely also *M. canetti, M. microti, M. africanum,* and *M. bovis* (De Jong *et al.* 2010). In dog, TB infection is caused by the bacteria *Mycobacterium tuberculosis*. Mycobacteria are non-motile, non spore-forming, aerobic, rod-shaped bacteria of 2–4 µm in length and possess a unique lipid-rich cell wall which gives the 'acid-fast' property by which they are known (Acid-fast bacilli or AFBs) and renders them resistant to many disinfectants and antibiotics. They can be divided into slow growing or rapid growing species. *M. tuberculosis* is slow-growing, non-pigmented and appears as cream colored 'breadcrumbs' on culture, often also described as 'rough, tough and buff' (Collins *et al.* 1997). The whole genome of *M. tuberculosis* (laboratory strain H37Rv) was sequenced in 1998 (Cole *et al.* 1998). Subsequent sequencing of clinical strains from around the world has illuminated pathogen diversity, evolution and spread (Comas *et al.* 2013). Six major geographic lineages of *M. tuberculosis* have been identified: the Euro-American, Indo-Oceanic, East-Asian (including Beijing strains), West-African 1 and 2, and East-African-Indian. Many studies have attempted to identify lineage-specific differences in clinical virulence and/or transmissibility, but results have been conflicting. These different findings may be the result of differences in the particular strains used for comparison, variation in host genetics, environmental influences or different study methodologies.

Transmission

The only cause of TB in dog is coming into contact with the disease. Since dogs have a natural immunity towards TB it is rare for them to contract it. However, if a family member in a home or around the dog has TB they can get it. In addition, if the dog was near another animal infected with bovine TB he is at risk as well (Anonymous, 2013). Tuberculosis is uncommon in dogs and cats. The New Jersey Department of Health reports that, "75% of canine cases are caused by *Mycobacterium tuberculosis*," which is most commonly transmitted by infected humans to animals. Cases in dogs are associated with repeated aerosol exposure from living with humans infected with tuberculosis, or consuming contaminated sputa, milk, or tissue (Anonymous, 2014). TB is a mycobacterial disease that is spread via contact with infected materials. It transmits from human which is easily spread via the air when an infected human coughs or if the dog eats

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contaminated tissue of any kind (Anonymous, 2013). The breathing in of infected droplets expelled from the lungs of an infected personor animal is the usual—though not the only—route of infection (Anonymous, 2014).

Scenario of Canine Tuberculosis

Canine tuberculosis is rarely diagnosed worldwide and as far as could be established has not previously been reported in South Africa. Parsons *et al.* in 2008 described a case of *M. tuberculosis* infection in a stray Maltese crossbreed dog with extensive multifocal pulmonary tuberculosis. This infection was shown to belong to the Beijing strain of *M. tuberculosis* by the IS*6110* restriction fragment length polymorphism (RFLP) genotyping technique.

An uncommon disseminated *Mycobacterium tuberculosis* infection was described in a 12-year-old female dog by Martinho *et al.* in the year 2013. A 12-year-old non-neutered cross-breed female dog was admitted to the Veterinary Hospital at the School of Veterinary Medicine and Animal Science, UNESP, Botucatu, State of Sao Paulo Brazil In January 2011. Bronchial washings, urine, and feces were subjected to polymerase chain reaction (PCR) restriction enzyme pattern analysis (PRA) (Telenti *et al.* 1993, Parish and Staker1998) and these specimens were positive for *Mycobacterium tuberculosis*.

Parsons *et al.*(2012) reported about Canine TB (*M. tuberculosis*) infection in urban area of South Africa. In post mortem survey, they cultured tissue samples of six animals for Acid-fast (ZN positively-stained) bacteria. Out of six, four cultures were confirmed as *M. tuberculosis*. They tested seventeen TB-exposed dogs by TST (Tuberculin Skin Testing). In those seventeen TB-exposed dogs, fourteen had OT TST responses of less than 5 mm, and three had responses of between 5 and 10 mm. In 12 of these animals the PPD^{av} TST gave no response at all, while two animals had responses greater than 5 mm. Additionally, they used novel IGRAs to detect immunological sensi-tization to *M. tuberculosis* antigens and identified a 50% infection rate in dogs in contact with smear-positive TB patients.

Szaluś-Jordanow *et al.* (2016) reported an unusual form of *M. tuberculosis* infection in a mixed-breed male dog of 10 kg body weight in Poland where massive intra cardiac tuberculomas were the main manifestation. In echocardiography, a lump of about 20 mm in diameter in the area of the left atrium was found. Almost one year later, the same dog was presented again in severe clinical state (fever, anorexia, weight loss, depression, cough, dyspnea, lymphadenomegaly, vomiting and recent episodes of fainting). In post mortem report, most prominent lesions i.e. diffuse pneumonia, fibrinous pericarditis and epicarditis as well as large, yellow, semisolid masses of caseous necrosis in the left and right atrium (30 mm and 15 mm in diameter,

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respectively) were observed *M. tuberculosis* was isolated on Lowenstein-Jensen slants and in Bactec *Mycobacteria* Growth Indicator Tube 960 liquid media from both pulmonary and cardiac lesions and confirmed by BD ProbeTec ET Direct Detection Assay and spoligotyping.

Turinelli *et al.* in 2004 reported *M. tuberculosis* infection in a 4 year- old male Boxer dog with a history of vomiting, diarrhea and weight loss moved from West Africa to Lyon, France, where it was further evaluated by applying Ziehl- Neelsen stain to both cytologic and histologic samples and was found positive for acid-fast bacilli. Bacterial culture of the pleural fluid was positive for *Mycobacteruim tuberculosis.*

Kontos *et al.* in the year 2014 reported a disseminated case of *Mycobacterium avium* infection in a Basset Hound dog in Greece. The dog was presented with anorexia, fever, diarrhea, significant level of splenomegaly and enlargement of mesenteric and superficial lymph nodes. Cytology of fine-needle-aspiration material, obtained from popliteal lymph node, revealed macrophages with intracytoplasmic, nonstaining, slender, rod-like structures, indicative of mycobacteria. Colony from bacterial culture of lymph node aspirated material which by means of molecular techniques (PCR amplification and hybridization of PCR products) was subsequently identified as*Mycobacterium avium*. This is the first report of disseminated *M. avium* infection in a dog in Greece.

Foster *et al.* in (1986) reported a case of cutaneous lesion caused by *Mycobacterium tuberculosis* in a 5-month-old female mixed- breed dog. The dog was examined because of non-healing wounds in the right submandibular region. Treatment with antibiotics and surgical excision was ineffective. Specimens of the right mandibular lymph node and surrounding tissues were submitted for bacteriologic culturing, which reveals *Mycobacterium tuberculosis*. The risk of infection of human beings who associate with dogs that have cutaneous wounds caused by mycobacteria is unknown.

In 1980, Liu *et al.* conducted a survey on 15,272 canine necropsies, in which natural infection with *Mycobacteruim tuberculosis* was found to have been diagnosed in eight dogs (0.05%). Pleural and pericardial effusion, ascites and hepatomegaly was found in radiographic examination. Granulomatous lesions with acid- fast bacilli were consistently found. *Mycobacterium tuberculosis* was isolated in lesions from lungs, liver or lymph nodes of five dogs. All eight dogs had a history of contact with human patients with tuberculosis.

In 2016, Park *et al.* reported a case of pulmonary *Mycobacterium tuberculosis* infection with giant tubercle formation in a male mongrel dog of eight years old with 4.9 kg body weight. A thoracic radiograph of the dog showed significant pleural effusion. An oval- shaped soft tissue density mass was identified above the

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heart base after removal of the pleural effusion. The cytological evaluation of the pleural effusion showed numerous negative- staining rod structures. Ziehl- Neelsen staining confirmed the presence of acid- fast bacilli. A polymerase chain test reaction confirmed *Mycobacterium tuberculosis* infection. This was the first reported case of canine pulmonary *Mycobacterium tuberculosis* infection in South Korea.

O'Toole *et al.* in 2005 reported a case of *Mycobacterium avium* infection in a 2-year-old castrated 5kg Shih Tzu- Poodle crossbreed dog. In histological examination of spleen, marked granulomatous splenitis with myriad intracytoplasmic acid-fast bacterial rods was found. Ultra structural examination revealed the presence of 3-4 µm long mycobacteria in phagolysosomes of epithelioid macrophages. Tissue extract of lightly fixed spleen was positive for *M. avium* 16S ribosomal RNA and negative for *M. tuberculosis* complex IS*6110* DNA by polymerase chain reaction testing. *Mycobacterium avium* was cultured from enteric lymph nodes sampled at necropsy.

In UK, Shrikishna *et al.* reported a case of pulmonary TB infection caused by *Mycobacterium bovis* a UK born female and her pet dog in 2009. Human *M. bovis*infection is extremely rare in the native UK population in the absence of unpasteurized milk consumption or residence abroad. Latent TB infection was also observed in a household contact.

In 2008, Haist*et al.* reported a case of *Mycobacterium avium* sub sp. hominissuis infection in 2 pet dogs (a 3-year-old miniature schnauzer and a 1-year-old Yorkshire terrier) that lived in different geographic regions in Germany in Germany. Necropsy findings was similar in both dogs. In the terrier, the greater omentum and a part of the right apical lung lobe showed changes similar to those in the lymph nodes. Furthermore, numerous white 1-mm nodules were found in the spleen (both dogs), liver (schnauzer) and costal pleura (terrier). Histologic examination showed (pyo-) granulomatous inflammation of lymph nodes, tonsils, liver, spleen, and greater omentum. Additionally, pyogranulomatous pleuropneumonia was present in the terrier, and a granulomatous enteritis and pyelitis in the schnauzer. However, multinucleated giant cells or mineralization was not observed. In both animals, Ziehl-Neelsen stain demonstrated large numbers of acid-fast bacilli within macrophages. Samples of lymph nodes and lung were processed for mycobacterial culture by using standard procedures (Löwenstein-Jensen, Stonebrink medium). Colonies emerging after 2-week incubation at 37°C were investigated by PCR targeting IS*1245* and IS*901* (Guerrero *et al.*1995, Kunze*et al.* 1992). In all samples, *M. avium* subsp. *hominissuis* was identified by growth characteristics as well as presence of an IS*1245*-specific and absence of an IS*901*-specific PCR product. Additionally, sequencing of *hsp65* was conducted (Carpenter et al. 1988), which indicated *M. avium* subsp. *hominissuis* in both dogs (GenBank accession nos. EU488724 and EU488725).

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Gay *et al*. in 2000 reported a case of *Mycobacterium bovis* infection in a dog in New Zealand. The chest of the dog demonstrated a concomitant pneumothorax, pleural effusion, and a consolidated area within the left caudal lung lobe in radiographic examination. An exploratory thoracotomy revealed this a ruptured granulomatous lesion. Subsequent histopathological, microbiological and genetic studies confirmed that *M. bovis* was the causative agent in that dog.

In 2006, Ellis *et al.* reported a case of *Mycobacterium bovis* infection in a six-year-old male bordercollie dogin a rural village in north Wiltshire. The dog was normal for all blood tests and urinalysis, abdominal ultrasound examination, and thoracic and abdominal radiography were unremarkable. In postmortem examination, there were no macroscopic changes in the abdominal organs. Cultural examination of tissues from spleen, mesenteric lymph nnodes, duodenum and adjacent pancreas, lung and heart muscle were done in Stonebrink's medium, Löwenstein-Jensen base, Löwenstein-Jensen with glycerol (LJG), Löwenstein-Jensen with pyruvate and Middlebrook 7H11. Except LJG, confluent growth typical of *M.bovis*was observed on all media, confirming the provisional diagnosis and identifying the causative mycobacterium. The isolate was further characterized by spacer oligotyping ('spoligotyping') by using the techniques of Aranaz and others (1996), and by variable number tandem DNA repeats (VNTR) analysis, according to the method of Frothingham and Meeker-O'Connell (1998). According to the international *M.bovis* spoligo typing database (www.mbovis.org), the isolate was identified as spoligo type SB0263 (commonly known in Great Britain as 'spoligotype 17') with VNTR pattern 7555*33.1. This particular spoligo type is predominant in tuberculous cattle and other mammals in Herefordshire, Worcestershire, Gloucestershire and Avon.

KuKanich*et al.* in 2013 reported a case of detection of *Mycobacteruim avium* subspecies *Paratuberculosis* from intestinal and nodule tissue of dogs and cats. In that, study seventy-three dogs and thirty-seven cats over two years of age were presented for necropsy between September 2009 and April 2011. The median age of dogs was 8 years old (range 2–15 yrs), and there were 63 purebred dogs and 10 mixed-breed dogs. Three of seventy-three dogs (4.1%) were positive for MAP by PCR, confirmed by DNA sequencing. After analysis in the NCBI-BLAST database of GenBank, the DNA sequences were nearly identical (99.0%) to IS900. MAP was identified from the distal ileum in two dogs and the mesenteric lymph node in one dog; no dog had multiple tissues positive for MAP. Of the 48 dogs with histopathology being performed on the gastrointestinal tract at necropsy, 10 dogs had gastrointestinal inflammation, including ulcerative disease (3 dogs), lymphoplasmacytic enteritis (2 dogs), infection (2 dogs), necrosis (2 dogs), and neoplasia (1 dog).

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Pathogenesis

Infection occurs when a dog inhales droplet nuclei containing tubercle bacilli that reach the alveoli of the lungs. These tubercle bacilli are ingested by alveolar macrophages; the majority of these bacilli are destroyed or inhibited. A small number may multiply intracellularly and are released when the macrophages die. If alive, these bacilli may spread by way of lymphatic channels or through the bloodstream to more distant tissues and organs (including areas of the body in which TB disease is most likely to develop: regional lymph nodes, apex of the lung, kidneys, brain, and bone). This process of dissemination primes the immune system for a systemic response. In latent tuberculosis infection (LTBI) and TB disease, droplet nuclei containing tubercle bacilli are inhaled, enter the lungs, and travel to the alveoli. In the alveoli, tubercle bacilli multiply and a small number of tubercle bacilli enter the bloodstream and spread throughout the body. The tubercle bacilli may reach any part of the body, including areas where TB disease is more likely to develop (such as the brain, larynx, lymph node, lung, spine, bone, or kidney). Within 2 to 8 weeks, special immune cells called macrophages ingest and surround the tubercle bacilli. The cells form a barrier shell, called a granuloma, that keeps the bacilli contained and under control (LTBI). If the immune system cannot keep the tubercle bacilli under control, the bacilli begin to multiply rapidly (TB disease). This process can occur in different areas in the body, such as the lungs, kidneys, brain, or bone (CDC, 2016).

Signs and Symptoms

In dogs infected with *M. tuberculosis*, if infection is by ingestion, the intestines are the primary target. Common signs include: weight loss, anorexia and harsh, non-productive coughing (Anonymous, 2014), depression, increased thirst and increased urination, diarrhea, jaundice (yellow tinge to the gums) and dehydration (Anonymous, 2015). If the infection occurred by bite wound, then clinical signs begin with skin granulomas (Anonymous, 2014). Other symptoms include, vomiting – While it is normal for a dog to vomit occasionally, this will be ongoing with no known cause or cure, lethargy – affected dog is no longer as active as he normally is and needs more rest time than before, cachexia – dog may present with a decline in his overall health, including many of the symptoms, leukocytosis – an increase in white blood cells in dog's blood work, shortness of breath – this may present out of nowhere or slowly over time (Anonymous, 2013). Dogs and cats may develop hyper salivation, retching, dysphagia and tonsillar enlargement due to oropharyngeallesions. Cutaneous lesions may include single or multiple ulcers, abscesses, plaques and nodules, commonly on the head, neck and limbs (Anonymous, 2012). Most infected dogs do not have any signs, as the canine immune system actively suppresses the bacteria. When disease does occur, signs generally include chronic coughing with difficulty breathing or quick, shallow breaths. Other generalized signs include weakness, poor appetite, and a low-grade, fluctuating fever (Anonymous, 2014).

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Diagnosis

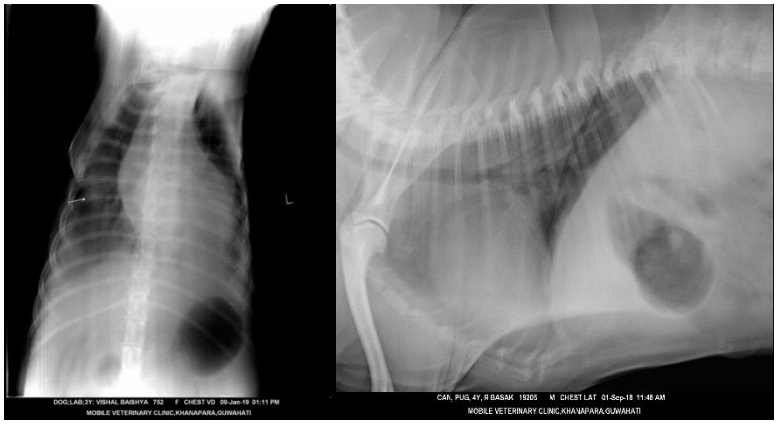
Diagnosis of TB infection in dogs is carried out by the following ways-

A complete blood count is usually done for suspected dogs.In positive dogs there is a significant increase in WBC, lymphocyte, THR, MPV, SGOT, SGPT and significant decrease in RBC, Hb, neutrophil, eosinophil, basophil, PCV, cholesterol, Ca2+ and phosphate compared to negative animals (Barua*et al.*,2018). However, a diagnosis or prognosis should not be based on haematological results solely, but should also take findings from the clinical examination or other diagnostic procedure into consideration (Roland *et al.*, 2014).

Biochemical profile can indicate the function of the organs and electrolytes and determine the overall health of the dog. Organ biopsy is necessary to diagnose tuberculosis definitively. Unfortunately, biopsy of the lung or intestines is invasive and the pets are typically quite ill. There is significant concern that the pet may not survive the anesthesia and procedure.

For those pets with respiratory difficulty, chest radiographs (x-rays) can indicate if pneumonia is present but does not confirm the diagnosis of tuberculosis. Frequently, tuberculosis may be confused with lung cancer since both have similar x-ray signs (Anonymous, 2015).

Radiography is carried out to detect pleural and pericardial effusion, ascites and hepatomegaly, diffuse radio-opaque images in lung lobes, diffuse visible masses in abdominal organs, hilar andmesenteric lymphadenopathy etc.



A B

Fig 2: Survey radiography of the thorax. A) Suspected lesion in the right lobe of lung (arrow) B) Pleural effusion can been seen (SIT positive reactor).

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Intradermal skin testing in dogs and cats is inconsistent and unreliable.However, the skin testis done by 3 intradermal injections of 0.1 ml of 2TU, 5TU and 10TU of Tuberculin PPD (Arkray Healthcare Ltd., Gujrat, India) in the medial aspect of thigh. Skin thicknesses were measured at both sites before the intradermal injection and after 72 hrs. If the skin thickness is more than5 mm consider as positive (OIE).

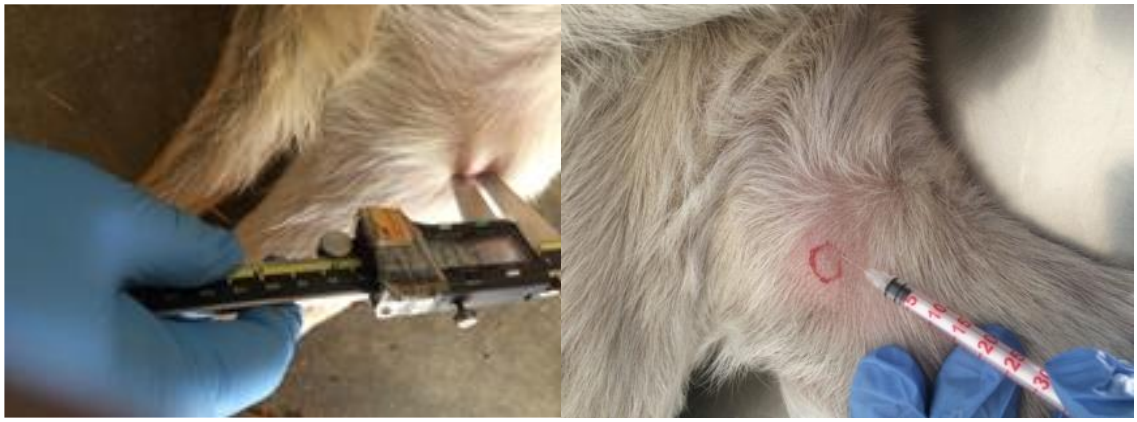

Fig 3: A) 0.1ml PPD (2, 5 and 10 TU) injected intradermally in the shaved area of medial aspect of the forelimb and thigh region of hind limb B) Positive results after 48hrs for 5 TU. (< 5 mm)

Serologically canine tuberculosis can be diagnosed with the help of recent technique like ELISA by detecting IFN-γ present in serum. A sample was considered as positive when the difference between mean optical density value of a negative control with mean optical density value of sample is equal or higher than 0.100.

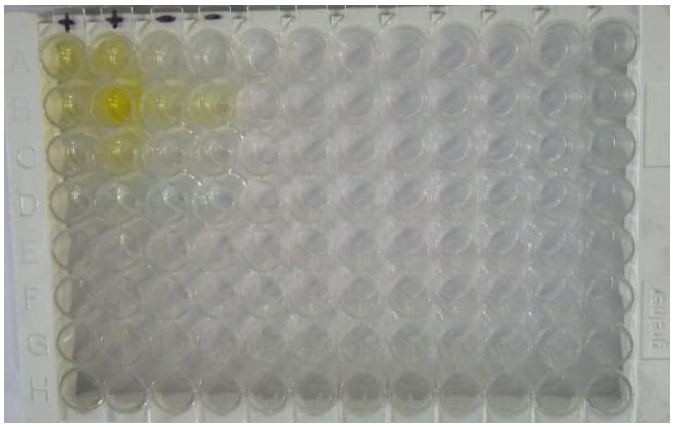

Fig 4: Canine Interferon gamma assay (RayBio Canine Interferon gamma (IFN-g) quantitative Elisa Kit)

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Dog TB is diagnosed by cytological and cultural examination, and histopathology of biopsy material. On cytology: organisms vary in number, but numerous organisms may be visible in the smear. With Wright's stain, the organisms are rod-shaped, refractile and non-staining. An acid-fast stain is needed to highlight the organism. Culture or PCR is then necessary to differentiate between mycobacterial species targeting selected gene like *hsp-65*, *pncA* and *oxy R* (Barua *et al.*, 2018).

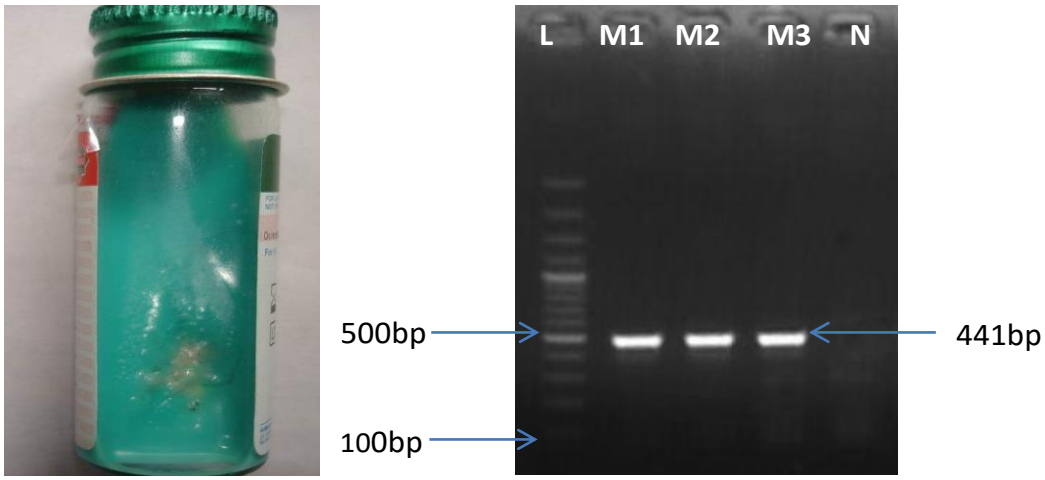

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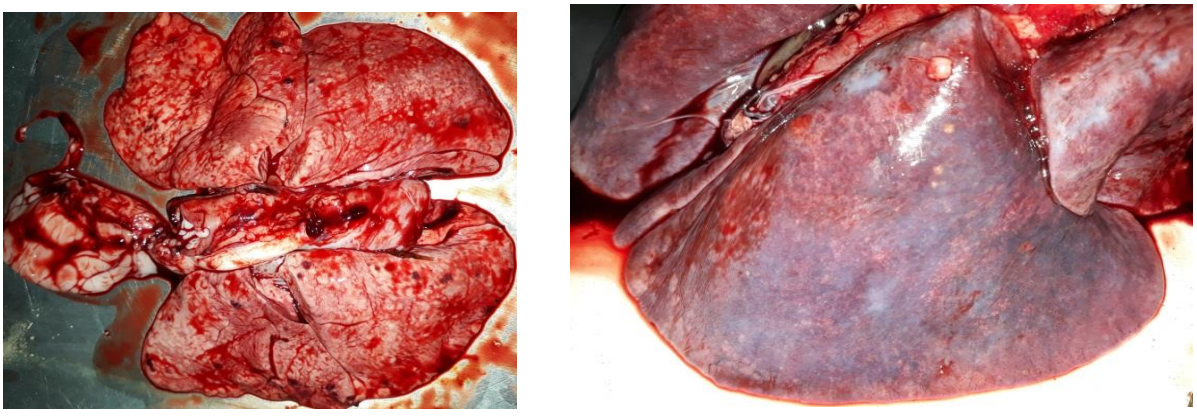
Fig. 5: A) *Mycobacterium tuberculosis* culture, B) PCR assay of *hsp65* gene for *Mycobacterium tuberculosis* complex; L: 100 bp ladder, M1&M2: Isolates in dublicate, M3: Positive control and N: Negative control.

The pathogen is slow growing and requires special media and several weeks to establish visible colonies. Post-mortem examination will reveal firm multifocal nodules, with necrotic centres in the caudal lung lobes, liver, kidney, pleura and peritoneum. The lesions are often exudative, discharging a yellow fluid into the thorax and abdomen (Anonymous, 2012).



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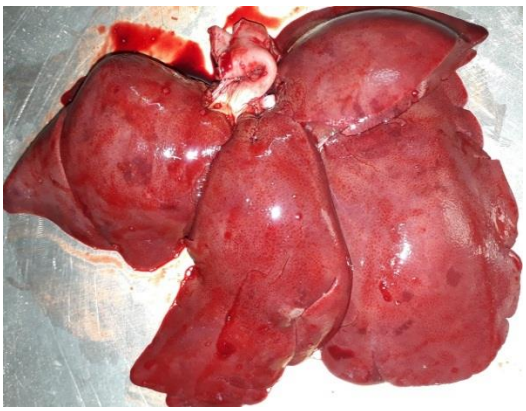

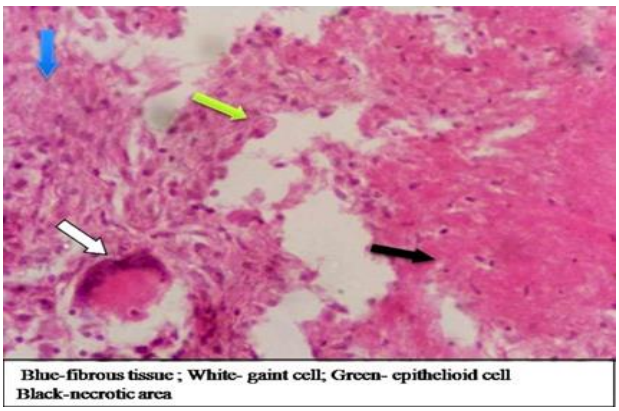

C D

Fig.6: Necropsy findings. A) Emphysema with the presence of focal patchy areas of haemorrhages in lungs. B) Focal areas of liquifactive necrosis, on incision creamy white materials ooze out. C) Hepatic parenchyma shows reticular appearance with focal areas of necrosis. D) Histopathological changes showing necrotic area surrounded by infiltrating cells like lymphocytes, epithelioid, Langhan'sgaint cell and fibrous tissue proliferation in lung. (Arrow). H& E 100X.

Treatment

Because of the uncertain potential for transmission of tuberculosis from the infected dog or cat to people, especially children, treatment is not recommended. Most animals diagnosed with tuberculosis are euthanized. Sadly, long-term medical treatment has not been proven effective (Anonymous, 2014). Treatment options are unfortunately limited to euthanizing the dog due to public health concerns (Anonymous, 2013). Because infections with the MAC organisms are opportunistic, usually with an environmental source, treatment may be attempted. Two or three antibacterials should be used intercurrently for 6-9 months. Drugs such as rifampicin, clarithrocymic, clofazimine, doxycyline and enrofloxacin have been used. Treatment should be continued until all clinical signs of the disease have resolved (Anonymous, 2012). All confirmed cases and possible cases will most likely need to be reported to the public health department as well. While the chance of canine to human transmission is rare, it is not a risk that is taken lightly (Anonymous, 2013). Treatment of tuberculosis in dogs should be discussed with veterinarian. If a dog is suspected of having advanced tuberculous lesions, it must be reported to the appropriate public health authorities, and the dog should be euthanized (Anonymous, 2014). Treatment of *M. tuberculosis* infections in dogs is controversial, mainly because of the human health risk. Nevertheless, there are no documented cases of *M. tuberculosis* infection spreading from dogs to humans, thus this disease is known to be an anthropozoonosis (Engelmann *et al.*, 2014).

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Prevention

There is no home care and preventive measure for tuberculosis. Tuberculosis is an uncommon disease but, due to antibiotic resistance, is slowly becoming more common. If dog is suspected of having tuberculosis, or someone in the family has tuberculosis, consult veterinarian immediately. Any person with tuberculosis must be very careful around dogs. Coughing can result in spread of the bacteria through the air and nearby dogs may be exposed (Anonymous, 2015). Some other preventive measures involved detailed owner education, isolation of the dog from immunosuppressed persons as well as young and elderly people, serial fecal examination for acid-fast bacteria to detect if the dog was shedding organisms, and serial physical examinations and diagnostic imaging to document potential progression to the pulmonary system (Engelmann *et al.*, 2014).

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