

# Spectrum of Radiological Findings in Leptospirosis on Chest Radiograph and Ultrasonography-Study during Epidemics in South Gujarat Region of India

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## ABSTRACT

**Introduction:** Leptospirosis is an acute generalised infectious disease caused by any of the group of spirochetes of the genus *Leptospira*. The disease can involve many organs mainly liver, central nervous system, kidneys, skeletal muscle, and lungs.

Diagnosis can be done on the basis of epidemiological, clinical and laboratory features. As the disease has varied manifestations, it is frequently misdiagnosed even in areas of high prevalence. A delay in diagnosis can lead to severe form of disease and development of its complications.

**Aim:** To find out involvement of thoracic and abdominal organs in each and every patient with the help of chest radiographs and Ultrasonography (USG) of abdomen and thorax.

Also, to put together the radiological spectrum of pulmonary manifestations, and other system involvement in leptospirosis during epidemics in south Gujarat region and their role in early diagnosis and follow up of patients.

**Materials and Methods:** Study was carried out for 3 years. Total 380 patients of suspected leptospirosis were referred during epidemic during months of July to October in year 2008, 2009 and 2010 for confirmation of diagnosis and management.

Total 275 patients were confirmed for leptospirosis by

serological test (ELISA) during first and second week of illness which was included in our study. All 275 patients were evaluated with chest radiographs and ultrasound of chest and abdomen. Those patients which are clinically suspected for leptospirosis but were serologically negative were excluded.

**Results:** Out of 275 confirmed patients of leptospirosis, 54 patients had signs of pulmonary haemorrhage on chest radiograph (19.65%). Out of these 54 patients 50 (which accounts 92% of pulmonary hemorrhage patients and 18% of total 275 patients) died due to severe pulmonary haemorrhage and respiratory distress. Pleural effusion was diagnosed on X-ray chest in 10 patients but it was found in 68 patients on USG. Signs of acute renal disease were found on USG of abdomen in 124 patients (45%). Hepatic involvement was found in 192 patients while 68 patients had multi organ involvement (24.7%). Changes of acute pancreatitis were noted in 11 patients while 16 patients had pericardial effusion and 198 patients had ascites.

**Conclusion:** Chest radiograph and USG study of each and every patient suspected of leptospirosis has got definite role in confirming different organ involvement and thus helps us in early diagnosis, planning treatment and for judgement of prognosis. As it is non-invasive and easily available procedure, it is also helpful for follow-up after treatment.

**Keywords:** Acute pancreatitis, Pericardial effusion, Pulmonary haemorrhage, Respiratory distress

## INTRODUCTION

Leptospirosis is an acute generalised infectious disease caused by spirochetes of genus *Leptospira* [1-3]. The disease is characterised by broad spectrum of clinical manifestations including fever, chills, headache, conjunctival haemorrhage, epistaxis and myalgia in early cases and mild variety of

leptospirosis while icterus, cough with haemoptysis, oliguria and renal failure in severe form of disease [1,2]. The extreme variation of clinical presentation is responsible for severe diagnostic dilemma. The differential diagnosis in endemic region includes dengue, typhoid, malaria and viral hepatitis [1]. The severe icteric form of infection is called as Weil's

disease, named after the investigator in 1886. The multisystem involvement results from the bacterial invasion and toxic reactions. Transmission of leptospira occurs either by direct contact with urine, blood or tissue of infected animal (rodents) or exposure to contaminated environment [1-4]. Human to human transmission is rare [2]. As the disease is responsible for multi-systemic involvement USG and chest radiographs are carried out in each and every patient for finding out involvement of particular organ and system, which helps in further management of patient.

## MATERIALS AND METHODS

This cohort type of study was conducted for evaluation of spectrum of findings of leptospirosis on X-ray and USG. Total 380 patients of suspected leptospirosis were referred to our tertiary care hospital (SMIMER hospital, Surat, Gujarat) for confirmation of diagnosis and management of patient during epidemics of leptospirosis during period of July to October 2008, 2009 and 2010 over the period of three years. As per protocol of our institute all patients were referred to Department of Radiodiagnosis and evaluated with chest radiographs and USG of chest and abdomen. All the patient/patient's relative were informed for the procedure and written informed consents were taken for chest radiograph and USG and for inclusion in the study. Approval from the ethical committee was taken.

Initial radiographs were taken within 2-3 days of onset of clinical symptoms. Follow-up X-ray were taken after 3-5 days interval. We retrospectively reviewed serial chest radiograph of these patient for pattern, distribution and sequential changes of pulmonary findings. HRCT was done in few patients with equivocal chest radiographic findings and few patients with severe respiratory distress. According to chest radiograph and abdomen USG findings patient were grouped under different categories, viz. Patient with pulmonary findings, abdominal findings, and patient with multiorgan involvement which are subdivided under various groups. Autopsy of all patients who died due to leptospirosis were performed.

### Inclusion Criteria

Out of 380 patents, 275 serological confirmed cases of leptospirosis by ELISA during first and second weeks of illness are included in this study.

### Exclusion Criteria

Those patients which are clinically suspected for leptospirosis but were serologically negative were excluded.

## RESULTS

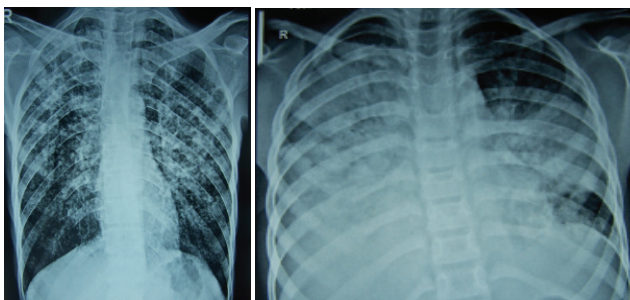
In our study 80% of patients were from agriculture profession and rural background. We observed, male preponderance with 80.72% (n=222) males and 15.63% (n=43) were females.

Highest incidence rate was seen in 20-40 years age group (60%). Urban and rural distribution of cases was 20% and 80% respectively [Table/Fig-1]. All the patients had general complaints of fever, chills, cough, headache and myalgia with jaundice in 54.18% cases (n=149). Acute renal failure was found in 45% cases (n=124). Haemoptysis and respiratory distress was seen in 19.64% cases (n=54) and signs of meningitis was found in 3.54% cases (n=9). Out of 275 confirmed patients of leptospirosis, 54 patients had signs of pulmonary haemorrhage on chest radiograph (19.65%). We found three types of pattern on chest X-ray, (1) Multiple tiny ill-defined nodules in both lung fields [Table/Fig-2] which subsequently become confluent (2) bilateral diffuse patchy infiltrate, which corresponds with scattered alveolar haemorrhage [Table/Fig-3]. This is most commonly found in the lower lobes and in the periphery of lungs. (3) Some patients showed consolidation [Table/Fig-4]. Out of these 54 patients of pulmonary haemorrhage 50 (92%) patients died due to severe pulmonary haemorrhage and respiratory distress. Pleural effusion was diagnosed on X-ray chest in 10 patients [Table/Fig-5] but mild effusion was found in 68 patients on USG [Table/Fig-6]. Clearing of lung opacity was patchy and multifocal during resolution of pulmonary haemorrhage-noted in follow-up radiograph of chest [Table/Fig-7]. In our study-total 29% of patient had abnormal chest radiograph which include pulmonary hemorrhage, pleural effusion and pericardial effusion.

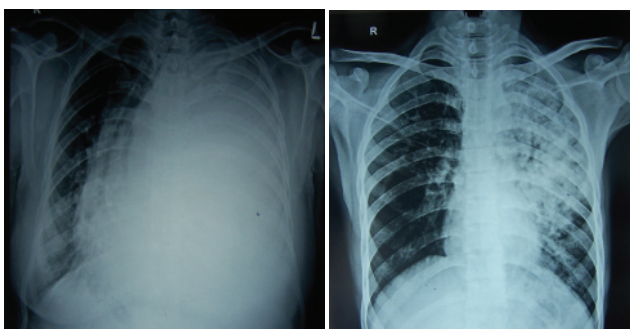
No permanent lung damage was noted in patients who survived. The patient who had abnormal chest radiograph needed longer hospitalization than those patients with other system involvement but normal chest radiograph. In 20 patients with equivocal X-ray findings or severe respiratory distress, X-ray findings were evaluated with HRCT [Table/

Demographic Findings (n=275)		
Variables	n	Percentage (%)
<b>Sex</b>		
Male	222	80.72
Female	43	15.63
<b>Profession</b>		
Agriculture	220	80
others	45	20
<b>Age Group</b>		
<20 yrs	44	16
20-40 yrs	165	60
>40 yrs	66	24
<b>Locality</b>		
Rural	220	80
Urban	45	20

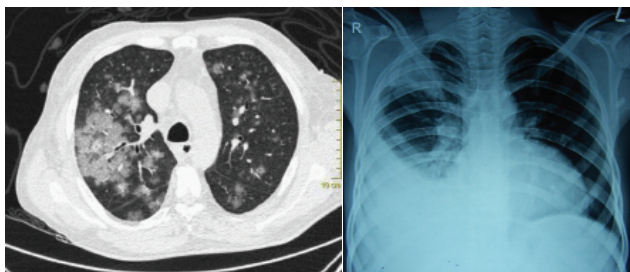
[Table/Fig-1]: Demographic findings.



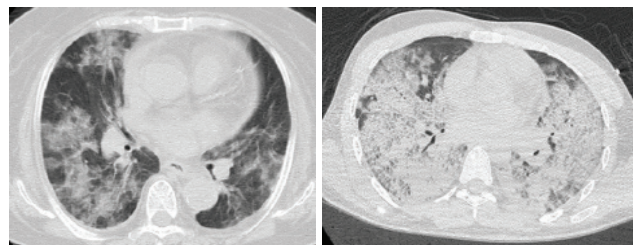
**[Table/Fig-2]:** Chest radiograph showing bilateral illdefined tiny nodular infiltrates-early phase of pulmonary hemorrhage. **[Table/Fig-3]:** Chest radiograph showing bilateral diffuse patchy infiltrates with obliteration of right CP angle-pulmonary hemorrhage and right pleural effusion.



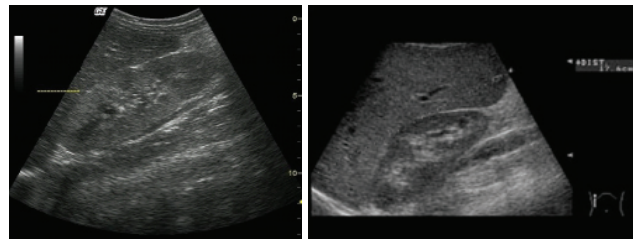
**[Table/Fig-4]:** Follow-up chest radiograph in same patient taken after one week showing ill-defined patchy opacities limited to left lung-resolving pulmonary hemorrhage. **[Table/Fig-5]:** Chest radiograph showing opaque hemithorax on left side with mediastinal shift to right side-left massive pleural effusion.



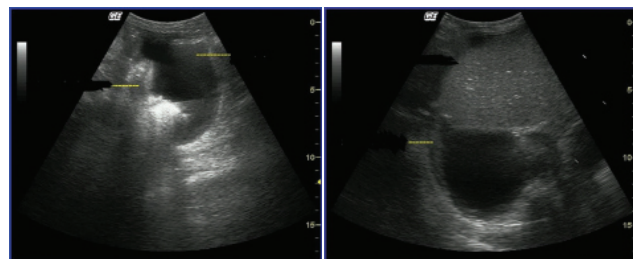
**[Table/Fig-6]:** Multiple tiny ground glass nodules in both lungs corresponding to tiny nodular opacities in both lungs-pulmonary hemorrhage. **[Table/Fig-7]:** Pulmonary hemorrhages presenting as consolidation in right upper lobe peripherally with right moderate pleural effusion.



**[Table/Fig-8]:** On subsequent HRCT confluent ground glass opacities and consolidation found. **[Table/Fig-9]:** Patient with severe pulmonary hemorrhage-confluent opacities and consolidation.



**[Table/Fig-10]:** Ultrasound abdomen showing renal enlargement with increased cortical echogenicity. **[Table/Fig-11]:** Ultrasound abdomen showing hepatomegaly.



**[Table/Fig-12]:** Ultrasound abdomen showing ascites. **[Table/Fig-13]:** Ultrasound of chest and abdomen showing pleural effusion.

cases decreased liver echogenicity.

68 patients had multi organ involvement (24.7). Changes of acute pancreatitis were noted in 11 patients while 16 patients had pericardial effusion that appeared as cardiomegaly on X-ray and pericardial fluid on sonography. 198 patients had ascites on sonography [Table/Fig-13]. Ten patient of acute pancreatitis and eight patient of pericardial effusion also died [Table/Fig-14].

## DISCUSSION

Leptospira are spirochetes belonging to the order spirochaetales and family leptospiraceae. They are fine spiral shaped bacteria with characteristic morphology seen under electron microscope. Organisms appear straight with both ends characteristically hooked and vary from 6 to 20 micron in length and 0.1 micron in diameter [3]. Living leptospira is excreted in the urine of infected rats. Rats are most common source of infection worldwide. Leptospira are capable of surviving in pools, canals, and damp soil. Poor hygienic conditions favour the pathogen's survival [2]. The portal of entry in human body is respiratory tract, gastrointestinal

Fig-8-10). HRCT particularly picks up ground glass opacities which can be missed on chest radiograph. These ground glass opacities, air space consolidation and air space nodules on HRCT are caused by air space haemorrhage [8].

Signs of acute renal disease were found on USG of abdomen in 124 patients (45%). This shows as increase size of kidney, varying degree of increase renal cortical echogenicity and perinephric increase fat echogenicity [Table/Fig-11]. Hepatic involvement was found in 192 patients in form of hepatomegaly [Table/Fig-12] course echotexture and in some



Findings	Percentage % (n)
pulmonary haemorrhage on chest radiograph	19.6%(54)
Pleural effusion on chest radiograph	3.6%(10)
Pleural effusion on USG	24.7%(68)
Pericardial effusion on chest radiograph and USG	5.8%(16)
Acute medical renal disease on USG	45%(124)
Hepatomegaly with coarse echotexture on USG.	69.8%(192)
Hepato splenomegaly on USG	24.7%(68)
Multiorgan involvement	24.7%(68)
Changes of acute pancreatitis on USG	4%(11)

**[Table/Fig-14]:** Summary of imaging findings.

tract or through abraded skin [4]. The peak incidence of leptospirosis occur in rainy season in tropical region [1,4]. Two types of human exposure occurs [4]-

1. Occupational exposure to farmers, veterinarians and abattoir workers.
2. Recreational exposure to campers and swimmers [1].

After penetration through the mucus membrane or abraded skin leptospira enter the blood stream and are carried rapidly to all parts of body including the CSF [5].

Multiplication of organisms takes place in blood and tissues. Leptospira can be isolated from blood and CSF during first 4 to 10 days of illness [2] and can be cultivated with special media from blood and CSF [5].

Since, solely on clinical signs and symptoms the diagnosis is difficult, leptospirosis should be differentiated from other illness like malaria, enteric fever, rickettsial disease and viral hepatitis by radiological and laboratory investigation.

Under diagnosis is responsible for increased mortality rates.

Leptospirosis is typically a biphasic illness. The leptospiremic or first phase lasts 4-9 days with an abrupt onset (75-100%) of chills, fever, headache, and myalgia. The second or immune phase usually lasts 1-3 days after a relatively asymptomatic period of 1-3 days. The reported mortality rate varies from 2% to 14% [6]. In the current study, the mortality rate is 24%. Higher mortality in our study was partly because of late presentation of patients to out tertiary care hospital with severe form of pulmonary manifestation and partly because of more patients with multiorgan involvement. Complete recovery after acute illness is usual in survived patient [6].

### Laboratory investigations

For diagnosis in the first week of illness-

1. Thick peripheral smear stained for spirochetes for dark field examinations.
2. Blood culture.

3. Raised leukocyte count to differentiate from viral hepatitis. For diagnosis after first week-

1. Micro Agglutination Test (MAT) - is sero group specific confirmatory test.
2. Compliment Fixation Test - is genus specific test can be used for screening sera.
3. Enzyme Linked Immunoabsorbant Assay (ELISA) - is genus specific test. It is useful for rapid diagnosis of leptospirosis as it can be used to detect early rise in IgM within 3 to 4 days of illness.

### Role of Chest Radiograph and Ultrasonography

Though, radio imaging modalities are not primarily useful for confirmation of diagnosis of leptospirosis, but with the help of chest radiograph and USG specific organ and system involvement can be identified. This helps in planning of treatment as well as to judge the prognosis while waiting for reports of serological test.

Pulmonary involvement in leptospirosis consists primarily of hemorrhagic pneumonitis. Pathologically, petechiae are scattered throughout the lungs and tracheobronchial tree. In advanced cases, extensive pulmonary hemorrhage and edema have been found. Little associated inflammation is present.

Direct toxic effect of the organisms or endotoxin of circulating Leptospira is probably responsible for widespread capillary damage [6]. In case of severe infection, pulmonary radiographic abnormalities are more common. They appear on chest radiograph generally 3 to 9 days after the onset of illness.

The disease can evolve very fast and can cause death in less than 72 hours. Severity of pulmonary symptoms usually reflects as severe radiological findings [7].

The reported frequency of abnormalities shown on chest radiographs in patients with leptospirosis varies from 11% to 67% [6]. This wide range is partly contributed by natural differences in the virulence of the disease in different parts of the world, differences in individual reactivity, and differences in selection of patients. In the present study, the frequency of abnormalities seen on radiographs was 29%. The patterns of abnormalities shown on chest radiographs have been variously described as-small patchy localized infiltrations, confluent massive areas of consolidation, widely disseminated small infiltrations, localized patchy clouding of different sizes, and snow flake-like small patchy lesions [3,6]. This is most commonly seen in the lower lobes and in the periphery of lungs [3]. Miliary opacities also have been reported [6].

In our study, patients with abnormal radiographs showed 3 types of pulmonary abnormalities, (1) Multiple tiny ill-defined nodules in both lung fields [Table/Fig-2] which subsequently

become confluent. (2) Bilateral diffuse patchy infiltrate, which corresponds with scattered alveolar haemorrhage [Table/Fig-3]. This is most commonly found in the lower lobes and in the periphery of lungs. (3) Some patients showed consolidation [Table/Fig-4].

Small nodular lesions typically progressed to large confluent air space consolidation or diffuse ground glass lesions before resolving. In patients with large air-space consolidation, progression to diffuse, ground-glass lesions was characteristic.

Viral pneumonia, bronchopneumonia, miliary or endo bronchial spread of tuberculosis, other causes of pulmonary hemorrhage such as Good Pasture syndrome, aspiration, bronchoalveolar carcinoma or adult respiratory distress syndrome may mimic findings of leptospirosis on chest X-ray [3,8,9]. However, certain characteristics radiographic findings help in differentiating radiographic abnormalities due to leptospirosis, ARDS and pulmonary oedema. ARDS chest radiographs tend to clear slowly as compared to those of leptospirosis. Pulmonary edema does not show peripheral distribution and also shows Kerley B lines [10,11]. [Table/Fig-15] shows comparison of imaging findings on chest radiograph and USG of abdomen among some common condition presenting with similar symptoms as leptospirosis.

In this study 54 patients (19.65%) presented with the same radiographic findings. They were admitted in intensive care unit for further management. Out of 54, 50 (92.6%) patients died due to severe pulmonary haemorrhage and respiratory distress. Pulmonary haemorrhage and ARDS are two of the most fatal conditions in leptospirosis [3]. Clearing of lung was patchy and multifocal during resolution of pulmonary haemorrhage noted in follow-up radiograph of chest. In this study total 29% had abnormal radiograph. No permanent lung damage was noted in patients who survived. The patient who had abnormal chest radiograph needed longer hospitalization than those patients with other system involvement but normal chest radiograph.

Tanomkiat W et al., studied 112 patients of leptospirosis and showed abnormal chest radiograph in 34 patients out of which 29(24%) patients had bilateral diffuse patchy infiltrates, tiny nodular opacities or pulmonary haziness-oedema and pleural effusion [3]. Compared to our study sample volume in this study is less. They studied only chest involvement by leptospirosis while we studied chest and abdominal organ involvement. In our study, ten patients had pleural effusion on chest radiograph, also confirmed with chest ultrasound but USG showed pleural effusion in 68 patients out of 275. Thus, USG is more sensitive in detection of pleural effusion than chest radiograph.

In study performed by Smiti S et al., they reported abnormal

chest radiograph in 47.1% patients in form of patchy consolidation with pleural effusion [1].

Compared to this study sample size in a study by Smiti S et al., was small, they studied only 51 patient compared to 275 patients in this study. They did not describe specific pattern of lung involvement on chest radiograph. Compared to the present study, previous studies related to leptospirosis no HRCT correlation is done in any cases. On ultrasound examination of abdomen and chest; involvement of different abdominal organs can be demonstrated according to stage and severity of disease. Liver shows enlargement with coarse hyperechoic echotexture. Intrahepatic biliary and portal radicles do not show any changes. In our study 192 patients (69.8%) presented with same ultrasound findings while study of Smiti S et al., reported hepatomegaly in 28 patients and hepatosplenomegaly in 13 patients out of 51 cases. Bilateral renal enlargement with increased renal cortical echogenicity and prominent renal pyramids are most common findings. Size of enlarged kidneys vary from 12 cm to 16 cm. We noted same findings in 124 out of 275 patients (45%) while in study by Smiti S et al., 64.7% patients had renal parenchymal changes [1].

In this study changes of acute pancreatitis were noted in 11 patients (4%) which proved fatal in ten cases, while in study by Smiti S et al., two patients (3.9%) out of 51 had acute pancreatitis which proved fatal [1].

198 (72%) patients had ascites while 68 patients (24.7%) had multi organ involvement found on USG. Pericardial effusion was noted in 16 patients (5.8%) in chest radiograph as well as on USG of chest.

In our study total 68 (24.7%) patients died. Out of them 50 had pulmonary haemorrhage while 10 had changes of acute pancreatitis and eight had pericardial effusion with multi organ

Radiological Finding	Leptospirosis	Malaria	Dengue Fever	Viral Hepatitis
Pulmonary Haemorrhage	Yes	No	No	No
Pleural effusion	Yes	No	Yes	No
Hepatomegaly	Yes	May be	Yes	Yes
Splenomegaly	Yes	Yes	Rare	Rare
Gall Bladder Wall Oedema	No	No	Yes	Rare
Pancreatitis	Yes	No	No	No
Ascites	Yes	No	Yes	May be
Acute Renal Failure	Yes	No	Yes	No
Pericardial Effusion	Some Patients	No	Some Patients	No

**[Table/Fig-15]:** Comparison of presence of imaging findings in clinical mimics.

failure confirmed at autopsy while in study of Smiti S et al., two patients died out of 51 patients [1]. Pulmonary haemorrhage was the cause of death in majority of patients.

## LIMITATION

We could not correlate every patient with chest radiographic findings with HRCT due to cost issue. We could not subcategorize exact no of patient with characteristic radiographic pattern during course of the disease as in many patient findings were overlapping.

## CONCLUSION

Chest radiograph and USG of thorax and abdomen are very much helpful to find out involvement of particular organs and system in patients of leptospirosis.

Even though manifestations of leptospirosis on chest radiographs may mimic viral pneumonia, bronchopneumonia, miliary or endobronchial spread of tuberculosis, other causes of pulmonary hemorrhage such as Good Pasture syndrome, or adult respiratory distress syndrome, the present study has shown that rapidly evolving, predominantly peripheral, diffuse nodular or confluent pulmonary lesions are typical of leptospirosis and, along with fever and an appropriate history, could reasonably suggest the diagnosis. Because the radiograph typically shows abnormality in the first 24 to 72 hours, it can often allow an early diagnosis and proper guide to management before serologic tests for leptospira become positive. Follow-up is done with these investigations to see effectiveness of treatment and improvement in affected organs.

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