Abstract: The hantavirus pulmonary syndrome (HPS) is an acute, rapidly progressive disease transmitted by rodent excreta, with endothelial damage playing a central role in the pathophysiology. It usually affects rural workers. The lung itself is the target organ and reflects all the patterns of endothelial involvement of this disease. The radiologic findings of HPS are vast and range from a mild interstitial involvement to total obliteration of the airspaces with or without pleural effusion. There are no specific findings on high-resolution computed tomography in HPS; nevertheless, findings of thickening of interlobular septa, ground-glass opacities, and occasionally small ill-defined nodular opacities have been described. The authors report a fulminant case of HPS and discuss its varied high-resolution computed tomography findings. To our knowledge, the “crazy-paving” pattern has not been seen previously in such cases.

Key Words: hantavirus pulmonary syndrome, high-resolution computed tomography, “crazy-paving” (J Thorac Imaging 2010;00:000–000)

The hantaviruses are single-stranded ribonucleic acid viruses that typically cause a symptom complex characterized by fever, hypotension, and renal failure, referred to as hemorrhagic fever with renal syndrome (HFRS), that has been reported mainly in Asia and Europe.1,2 In 1993, during an outbreak that occurred in the Four Corners region in the southwestern United States, a new type of Hantavirus (Sin Nombre virus) was described as the agent responsible for a disease that was frequently fulminant and that had prominent pulmonary involvement—the hantavirus pulmonary syndrome (HPS).1,4 Subsequently, several other cases of HPS were reported in Brazil, Argentina, and Bolivia and in subsequent years also in Chile, Canada, Paraguay, and Uruguay.3,5–8 Initially the lethality of the disease ranged from 50% to 100%, depending upon the country and the outbreak; in recent years, the rate has decreased (35% to 40%).4,9

The radiologic findings of HPS tend to be rapidly progressive and are characterized mainly by pulmonary edema, with a normal-size heart.5,9 To our knowledge, the high-resolution computed tomography (HRCT) findings have only been reported in 1 case and included ground-glass opacities, interlobular septal thickening, thickening of the bronchial walls, and pleural effusion.19

We report a case of a patient with HPS, with extensive interstitial and airspace involvement that evolved unfavorably, with varied and pleomorphic findings by HRCT. To our knowledge, the pattern of “crazy paving” had not yet been described in patients with HPS.

CASE REPORT

The authors report a case of HPS in a 45-year-old male, previously healthy patient living on a small farm, with a history of abrupt complaints of dyspnea, myalgia, fever, and malaise. He presented at emergency room admission with tachycardia and an axillary temperature of 39°C (102.2°F). Laboratory tests showed thrombocytopenia, hemocentration, and mild leukocytosis. An admission chest radiograph was unremarkable. The patient was promptly hospitalized because of worsening dyspnea. After 24 hours of admission, the patient presented acute desaturation, requiring transfer to the intensive care unit and artificial ventilation. The follow-up radiograph showed findings consistent with interstitial and airspace pulmonary edema and normal heart size.

Helicoidal HRCT was obtained on an Aquilion 64-Multi Detector CT scanner (Toshiba Medical Systems) with 0.5-mm thick axial slices (0.5-mm/0.5 s of table feed) at 0.5-mm interval reconstructions, and tube voltage of 120 kV at 181 mA. The contiguous slices were reconstructed at a 1-mm interval using a high-spatial-frequency bone algorithm. The lung window and level settings were 1500 and 700 HU, respectively. HRCT demonstrated smooth septal thickening, peribronchial cuffing, central ground-glass opacities, dependent areas of consolidation, and bilateral pleural effusions (Fig. 1). Smooth thickening of the interlobular septa and intralobular lines were seen superimposed on the ground-glass opacities, resulting in a crazy-paving pattern (Fig. 2). Chest radiographs over the next few days showed progressive worsening of the pulmonary edema pattern, with progressive consolidation and increase in the size of the bilateral pleural effusions. The patient died of cardiorespiratory failure on the fifth day of hospitalization. Serological studies were negative for anti-dengue IgM and IgG, yellow fever, and leptospirosis. The definitive serological diagnosis was made by the presence of enzyme-linked immunosorbent assay antibodies IgM for the Sin Nombre virus in the serum.

DISCUSSION

The family Bunyaviridae is composed of 5 classified genera of enveloped, single-stranded ribonucleic acid viruses (www.ncbi.nlm.nih.gov/sites/entrez?db = taxonomy), encompassing one quarter of known arboviruses. The Hantavirus genus is an exception to the other arboviruses because they are transmitted by rodents rather than arthropods. All strains of hantavirus that cause disease in humans infect the endothelial cells, inducing an increase in vascular permeability and leading to 2 different acute entities: the HPS, which is more prevalent in the Americas;
The lung is the target organ with an anatomic and pathologic substrate related to interstitial pneumonia, resulting in pulmonary edema with diffuse alveolar damage, focal hyaline membranes, and interstitial mononuclear infiltrate, with interstitial and alveolar fluid extravasation. The endothelial damage is the key pathophysiology factor, which causes an increase in the capillary permeability. The lung is the target organ with an anatomic and pathologic substrate related to interstitial pneumonia, resulting in pulmonary edema with diffuse alveolar damage, focal hyaline membranes, and interstitial mononuclear infiltrate, with interstitial and alveolar fluid extravasation. The endothelial damage is the key pathophysiology factor, which causes an increase in the capillary permeability.

The initial symptoms are fever, myalgia, tachycardia, and malaise, followed by cardiopulmonary events, after an incubation period of up to 39 days. The respiratory distress is typically severe and rapidly progressive, which can lead to respiratory failure and cardiogenic shock. A setting of fulminant illness and cardiogenic shock, there is usually a rapid course and a high mortality rate, despite supportive treatment. The most common laboratory changes include thrombocytopenia, hypoxemia, hemocentration, leukocytosis, and neutrophilia. The dyspnea, itself uncomfortable and disabling, is the leading cause that makes the patient seek medical attention.

Interstitial pulmonary opacities are accompanied by fever and dyspnea. The radiologic findings related to the HPS are variable, predominating with pulmonary edema with normal size heart characterized by Kerley B lines, hilar blurring, and thickening of the bronchial walls that can evolve into airspace compromise with consolidation of the foci and bilateral pleural effusion. In cases in which there are early signs of airspace disease, high mortality is associated.

In a series of 16 patients with HPS by Ketai et al, which occurred in the southwestern United States, all patients presented with interstitial opacities of variable degree in at least one chest roentgenogram taken during the course of the disease. All patients who had extensive airspace involvement in the initial radiograph died. Of those who had extensive airspace involvement after 24 to 48 hours, 44% died. The vast majority (95%) of the patients studied were living in rural areas.

In a survey with 20 cases of HPS from western Canada, Boroja et al found an initial variable pattern of interstitial involvement in all patients. About 75% of patients who had rapid progression to bilateral airspace consolidation had rapid progression to respiratory failure and needed hospitalization in the intensive care unit. In this group, the mortality rate was 46%; their death occurred on average during the first 2 days of hospitalization. The group of patients who had minimal involvement of airspace did not require intensive care and were released on average in less than 8 days. Similarly, 95% of the patients lived or worked in rural areas.

Descriptions of standard protocols and CT and HRCT findings are scarce and nonspecific, and were similar to those found in pulmonary edema, such as ground-glass opacities, interlobular septal thickening, and occasional small ill-defined nodular opacities. The HRCT findings of the present case consisted of ground-glass opacities, septal thickening, crazy paving pattern, areas of consolidation foci, and bilateral pleural effusion.

The pattern of crazy paving is not a specific finding. It refers to the thickening of interlobular septa and interlobular lines superimposed on a background of ground-glass opacity and is a very common finding in HRCT.
initially described in alveolar proteinosis, but present in a variety of causes including infectious, neoplastic, idiopathic, inhalation, and blood disorders.\textsuperscript{18,19}

The dorsal ventral gradient of lung opacity seen in this case (ground-glass opacities interposed between normal-appearing lung and consolidation) is typical of diffuse alveolar damage,\textsuperscript{20} likely representing a stage in the progression of HPS in which both endothelial and epithelial damage are present.

Late stages of HPS may be accompanied by cardiogenic shock. This may be functional, caused by a circulating toxin, or due to myocarditis.\textsuperscript{21} Accordingly, although this study was not cardiac gated or contrast enhanced, some pertinent observations might still be made about the patient’s hemodynamics. By the findings of gross cardiac size, pulmonary artery diameter, and inferior vena cava diameters within normal limits, we can extrapolate that cardiac decompensation was not a major contributing factor to the lung edema, being solely a result of alveolar damage.

To our knowledge, this unique example of HPS, which was expressed with a constellation of findings on HRCT, is suitable to illustrate all stages of alveolar damage, from the interstitial involvement with smooth septal thickening, ground-glass opacities, crazy paving to airspace obliteration, and bilateral pleural effusion.

REFERENCES


