Thoracic radiograph is a crucial part of diagnosis of feline disease. However, radiographic interpretation of feline thorax is still challenging. There are little anatomic and physiologic differences compared to dogs and other species. For routine thoracic radiology, the full inspiratory orthogonal lateral and either VD or DV are required. The position while taking a radiograph has a significant effect on the appearance of thoracic radiographs in cats. The evaluation of thoracic radiograph included intra-thoracic and extra-thoracic structures. A systematic approach to assessing radiographs will help to identify abnormalities which leading to further efficient treatment. The following systematic approach orders can be ribs, vertebrae, and sternum, soft tissues of the thoracic wall, pleural space, mediastinum, heart, trachea and principal bronchi, pulmonary vessels and the pulmonary parenchyma. However, obtained radiograph in dyspnea or unstable cat should extremely be careful because the restraint will cause exacerbate stress to the patient which may even be lethal. Therefore, before taking a radiograph, the cat should being stabilized. Radiographic abnormality interpretation is recognition of altered Roentgen sign which are changes in size, shape, margination, opacity, number and position or distribution.

Normal anatomical and positional variation
Unlike dogs, the normal chest conformation of cats is angular and the caudal pleura reflection appears more triangular than dogs. The cat has highly flexible chest cavity, thus an improper position can induced sternal curvature which common misunderstood as sternal deformity (1). In the cat, the lung fields do not extend to fill the angle between the spine and the diaphragm (the lumbodiaphragmatic recess) on a lateral radiograph, as they do in the dog (2).

The heart is located in the middle mediastinum. The normal cat heart is elongate and elliptical in shape measures 2.2.5 intercostal spaces in width and normal vertebral heart score is 7.5 +/- 0.3 vertebral bodies (3). The heart border has well-defined line and the caudal border is straighter on lateral view. In geriatric cat, the heart will gradually tilt cranially and ventrally with ages as an exaggerated horizontal alignment. Bulging of aortic arch and torturous redundant aorta are normally seen on lateral view. The heart of kitten generally appears larger than that of adult cat because of smaller lung volume; this produces an increase cardiac/thoracic ratio (1).

The thoracic airway start from the trachea which terminated at tracheal bifurcation (carina) and turns into two main stem bronchi into both sides of lung, then taper down to lobar bronchi goes on each peripheral lung lobes. The cat has 6 lung lobes same as carnivore species divided into divided into left and right sides; left lung has 2 lobes; left cranial which subdivided into cranial and caudal part and caudal lung. The right lung has 4 lobes: cranial, middle, caudal and accessory lobes.

The esophagus located in dorsal mediastinum. In normal cats, the caudal third of the muscular layer is composed of smooth muscle, which is arranged obliquely creating a striated pattern (herringbone appearance) on contrast esophagrams (3). On lateral radiographs, the normal caudal thoracic esophagus contains a small amount of fluid or gas that can be visualized as a tubular structure between descending aorta and caudal vena cava.

Pleur al abnormality
Most common abnormality of feline pleura is pleural effusion which is presence of fluid in pleura that can be unilateral or bilateral effusion. The radiographic features consist of widening pleural space with soft tissue or fluid opacity, visualization of interlobar fissures and retraction of lung margin from thoracic wall. Excessive pleural effusion can hidden intra-thoracic structures; loss of cardiopulmonary detail, loss of mediastinal and diaphragmatic definition and dorsal displacement of trachea which mimic elevated trachea from cranial mediastinal mass. There are several types of pleural fluid depends on its pathology. We can not determine fluid type from the radiographs Fluid sampling by thoracocentesis and analysis should be performed for further diagnosis. Repeat thoracic radiograph after drain out pleural fluid can allow identifying underlying intra-thoracic abnormalities.

Pneumothorax is presence of free air in pleural space produces varying degrees of lung collapse. Most pneumothorax in cats is the result of trauma such as dog bites, car accidents, and high rise syndrome. Less common is spontaneous pneumothorax, presence of free air in pleural space without external chest wound, probably causes included ruptured paragonimus lung cysts, perforated esophageal foreign body, cavitory lung lesion such as abscess, rupture of an apical bleb and iatrogenic causes e.g. lung biopsy or resuscitation-related cardiac massage. The radiographic features are radiolucent air-filled pleural spaces with inability to detect vascular...
shadow in peripheral lung field, pulmonary atelectasis and heart appear to be elevated from sternum in lateral projection. Pleural disease clinically results in dyspnea but not coughing.

**Mediastinal abnormality**
Mediastinal masses are common in cats. Radiographically, affected cats have a visible soft tissue opacity mass in widening cranioventral mediastinum. A large mass can create mass effect on adjacent organs such as caudal displacement of the heart, dorsal displacement of thoracic trachea, deviation and compression of thoracic esophagus, and may produce dyspnea secondary to compression atelectasis of the cranial and middle lung lobes or secondary pleural effusion. The most common cranial mediastinal mass in a cat is lymphoma, about 80% are associated with feline leukemia virus infection (FeLV) (1). Other differential diagnosis of cranial mediastinal masses are thymoma, mediastinal lymph node enlargement or branchial cysts (2). Pneumomediastinum is presence of free air in the mediastinum. The radiolucent air allows visualization normally invisible intra mediastinal structures. Common causes of pneumomediastinum in cats are tracheal puncture, tracheal laceration or neck laceration due to bite wound.

**Cardiopulmonary abnormality**
The assessment of cardiac abnormalities is not only recognizing changes in cardiac size and shape but also evaluate pulmonary vessels and parenchyma for the failure sign as well. The cardiogenic pulmonary edema patterns of cats differ from dogs. Distribution of edema is variable and can occur anywhere in cat’s lung. The pattern varies from patchy interstitial to distinct alveolar pattern with air bronchogram and lobar distribution concurrent with pulmonary vessels dilation. The common acquired cardiovascular disease in cats is hypertrophic cardiomyopathy. The radiographic characteristic is cardiomegaly with the valentine shape on ventrodorsal or dorsoventral view. The valentine shape is typically due to extreme enlargement of the left atrium and extends to the right side of the patient rather than bialtrial enlargement (3). On lateral view, an enlarged left atrium is not obviously seen bulging at caudodorsal aspect of the heart or splitting main stem bronchi as in dog’s heart because its left atrium is more cranially locate and superimposed on the cardiac silhouette so the cardiac will become widening and may create focal concave defect in the caudal cardiac border. The congenital heart disease, the radiographs tend to be generalized cardiomegaly e.g. tricuspid dysplasia which is one of the most common heart disease in cats. However, in some cardiac disease or even in heart failure cat, the cardiac silhouette also appears normal. Thus radiographs are actually poor modality to assess the heart, echocardiography is greatly superior.

The radiographic observation of feline pulmonary disease is the changes in pulmonary opacity which can be increased or decreased opacity. Pulmonary pattern divide to alveolar, interstitial, bronchial and vascular pattern similar to dogs. Differential diagnosis of pulmonary disease based on pattern recognition, lesion distribution and presence of secondary lesion. One of common feline lower airway diseases is feline asthma; synonym is feline allergic bronchitis, which clinically results in coughing, wheezing and dyspnea. The radiographic features depend on its severity and stages. In mild degree, radiographs may be normal. In severe degree, radiographs showed generalized bronchial pattern, lung tend to be hyperinflated and less opaque due to trapping of air, flattened diaphragm will be occur secondary to hyperinflation of lung and collapse of right middle lung lobe due to exudates obstruct bronchus which mostly present in chronic stage.

In pneumonia cat, the radiographs present ill-defined regions of increase opacity with typically ventral distribution, affect on peripheral and mid portion of right middle and both cranial lung lobes and possibly extend to the hilus with increase severity of the disease. Fungal pneumonia has typically more diffused distribution than bacterial pneumonia with unstructured interstitial to indistinct nodular appearance. Tracheobronchial lymphadenopathy and pleural effusion are also present.

Non-cardiogenic pulmonary edema distribute in mid part to peripheral portion of caudal lung lobes. The possibly causes included electric shock, seizure, near drowning, smoke inhalation and strangulation (4). The primary lung tumor in cat may present as solitary solid mass but other appearances such as cavitary or multicentric lung tumor e.g. bronchoalveolar carcinoma can also be observed. The multicentric tumor often result in diffuse interstitial proliferation of tumor cells without formation of a large mass. There may be nodular appearance in the lung which may mimic with some types of lung infection or metastatic tumor. Metastatic lung tumor in cats usually result in multiple pulmonary nodules. Nodal due to metastatic neoplasmia in cat can be small and poorly defined due to diffuse tumor infiltration in the interstitium. Anyway, needle aspirate or biopsy will be needed for definitive diagnosis of lung neoplasia.

In conclusion, thoracic radiographs are typically the first line of imaging in the work up of feline patients. Because cats are not small dogs, understanding of the normal radiographic appearance is necessary to fully recognize abnormal changes in feline thorax. However, differentiation between pulmonary inflammatory or infection and neoplastic lesions cannot be achieved on the basis of their imaging appearance; tissue sampling via needle biopsy, fluid
aspiration or bronchoalveolar lavage are necessary to conclude a final diagnosis.

References