ANATOMY FOR THE CLINICAL PRACTITIONER - I

By
DR. C. VIJAYARAGAVAN, Ph.D.,
Professor and Head, Department of Anatomy
Madras Veterinary College, Madras
And
Dr. R.V. PRASAD, Ph.D., Scholar,
Department of Anatomy,
Madras Veterinary College, Madras

THORACIC CAVITY AND PLEURA

The rib cage or thorax, is a part of the skeleton and consists of the thoracic vertebrae, the rib and their cartilage, and the sternum. It has the shape of a laterally flattened cone open at both ends; at the apex (cranially) is the small thoracic inlet, and at the base (caudally) a very wide thoracic outlet, closed by diapharagm. The inlet is formed by the first thoracic vertebra above, the first pair of ribs, on the sides and the manubrium sterni below. The outlet is formed by the last thoracic vertebra above the last pair of ribs, the costal arch (consisting of costal cartilages not attaching to the sternum on the sides) and the last sternebra and xiphoid process below:

When the bony thorax is in situ, i.e. when the remaining components of the thoracic wall (skin, fasciae, and muscles) are present, and when it is closed caudally by the diaphragm, a cavity known as the thoracic cavity results. The thoracic cavity occupies only the cranial portion of the bony thorax, the caudal portion, the intrathoracic part of the abdominal cavity, contains abdominal organs. The thoracic cavity, therefore, is smaller than the thorax and varies in size constantly with the respiratory movements of the ribs and diaphragm.

The thoracic inlet is an important passage for organs and vessels passing between the neck and the thoracic cavity. It is marked externally by the palpable cranial end of the sternum, and in roughly dorsoventral sequence, contains the longus colli; Oesophagus, trachea; the arteries and veins supplying head, neck, forelimbs, and lateral thoracic wall; lymphatics and nerves; and in young animals the thymus. These structures are embedded in loose connective and adipose tissue.

The endothoracic fasica the internal layer of trunk fascia that lines the thoracic cavity, is a sheet of fibrous and elastic tissue

attached to the deep surfaces of the ribs, intercostal muscles, sternum, and the transversus thoracis. It is reflected caudally onto the thoracic surface of the diaphragm and blends with its tendinous centre. The sternopericardiac and phrenico- pericardiac ligaments detach themselves from the endothoracic fascia at the sternum and diaphragm respectively and unite with the fibrous pericardium surrounding the heart.

The pleura covers the endothoracic fascia and the organs in the thoracic cavity. It is serous membrane, like the peritoneum and forms two laterally flattened semicones, the pleural sacs, each enclosing a pleural cavity of which the right is larger than the left. The pleura forming the lateral walls of the pleural cavities, the costal pleura is applied against the ribs. Caudally, the pleura covering the diaphragm, the diaphragmatic pleura forms the bases of the cone shaped pleural cavities. Medially, where the walls of the two pleural cavities lie back to back forming the mediastinum, the pleura is called the mediastinal pleura. The mediastinum thus a sagitally placed partition consisting of two serous membranes extending from the theoracic inlet in front to the diaphragm behind, and attaching dorsally to the thoracic vertebrae and ventrally to the sternum. Between right and left mediastinal pleura is a supporting layer of connective tissue.

Inserted at about the middle of the mediastinum, and spreading the right and left mediastinal pleura far apart, is the heart with its fibrous and serous pericardial coverings. The mediastinum is thus divided into a cranial mediastinum lying cranial to the heart, a middle mediastinum which contains the heart, and a caudal mediastinum caudal to the heart. In the cranial mediastinum are found the thoracic part of the longus colli, part of the trachea; part of the oesophagus; the large vessels supplying the lateral thoracic wall, forelimbs, neck and head, the sympathetic trunks, vagi, phrenic, and recurrent nerves; the cranial mediastinal lymphnodes; the end of the thoracic duct; and the thymus in young animals. In the middle mediastinum are found the heart and pericardium, the large blood vessels at the base of the heart, parts of the trachea and oesophagus, the vagi and the phrenic nerves. In the caudal mediastinum are found the aorta, part of the oesopha gus, dorsal and ventral vagal trunks, caudal mediastinal lymph nodes, and the left phrenic nerve in its separate serosal fold. Ventral to the aorta and to the right of the oesophagus is a small, closed serosal cavity which was cut off from the omental bursa in the abdominal cavity by the developing diaphragm. It is small in the ruminants and horse, but in the dog and pig, it extends forward from the diaphragm to the root of the lung, and may extend caudally through the oesophageal hiatus of the diaphragm into the space between the two layers of the gastrophrenic ligament.

The lungs develop as buds of the trachea and grow laterally into the pleural cavities. They push the pleura ahead of

them, and thus become invested with a serous covering, the visceral or pulmonary pleura. Caudal to the root of each lung there is a fold of pleura, the pulmonary ligament which connects the mediastinal surface of the lung with the mediastinum or when it extends further caudally, with the diaphragm, as in the carniovores and pig. In the ruminants, the mediastinal surface of the lungs caudal to the root adheres to the mediastinum without the interposition of pleura, so that there is only a short pulmonary ligament at the caudal end of the adhesion. In the horse the surface between the lung and mediastinum is even more extensive, so that the short pulmonary ligament is at the diaphragm.

At birth the mediastinum is a complete sagittal partition between the right and the left pleural cavities. In the carnivores and the horse, however, openings appear postnatally in the ventral part of the caudal mediastinum through which the two pleural cavities can communicate. Such openings are absent in the ox and goat, are rare in sheep, but have been observed in the middle mediastinum of carnivores, and in the cranial mediastinum of lean sheep.

In the dog although fenestrated, the mediastnum provides an effective barrier to fluid, air and infection.

The laterally flattened apices of the pleural sacs, the cupulae pleurae, are at the thoracic inlet; the right one, in carnivores and ruminants projects beyond the cranial border of the first rib (by 6-7cm in the ox), while the left one projects beyond the cranial border of the first rib only in the carnivores.

Because of the convexity of the diaphragm, the costal pleura adjacent to the diaphragm lies against the diaphragmatic pleura, with only a narrow capillary space intervening. This space is the costodiaphragmatic recess, and is in full communication cranio- dorsally with the pleural cavity. It is opened by the caudoventral movement of the lungs during inspiration.

In the caudoventral part of the right pleural cavity is a mediastinal recess produced by the caudal vena cava and the serosal fold that encloses it. The caudal vena cava passes through the right pleural cavity from the foramen venae cavae in the diaphragm to the right atrium of the heart the blicae venae cavae extends from the ventral border of the vena cava to the floor of the pleural cavity and is attached cranially to the heart and caudally to the diaphragm, thus separating the mediastinal recess from the rest of the right pleural cavity. The walls of the recess are as follows: left, the caudal mediastinum proper; cranially, the pericardium, right, the plicae venae cavae; and caudally, the diaphragm. The recess is open dorsally, and through the opening hangs the accessory lobe of the right lung which fills the recess.

PERCUSSION AND AUSCULTATION OF THE LUNG:

OBJECTIVES:

1. To recognize different degrees of resonance and to understand the reasons for different percussion sounds.

2. To trace the boundaries of the normal area of percussion and ausculation of the lung in each species.

3. To learn the technique of determining the basal border of the lung by the method of maximum contrast as below:

a. A reduced area of lung resonance caused by pneumonia in the ventral part of the lung, pleural transudate shown as a fluid level, on enlarged heart in the dog or horse, traumatic pericarditis in the cow, and abdominal organs of greater density than lung occupying the pleural cavity as a result of a ruptured diaphragm.

b. Increased area of lung resonance caused by emphysema (heaves)

c. Increased resonance resulting in a tympanitic sound over the lung area caused by pneumothorax. In small animal this is often caused by internal injury in a car accident The thorax is compressed with the glottis closed, and the alveoli rupture through the pulmonary pleura.

5. To trace the diaphragmatic line of pleural reflection in each species and to perform pleurocentesis at the proper point puncturing the heart or pericardium or injuring the intercostal vessels, or in the horse, the superficial thoracic vein.

6. To recognize the quality and extent of the normal breath sounds heard on auscultation in the dog, ox and horse.

7. To recognize the stenotic sound heard over the trachea and over the lung in pathological conditions.

The cranial border of the lung area is the same in all animals, as is the dorsal border. The cranial limit is the tricipital line, from the caudal angle of the scapula to the olecranon. The dorsal border is on a line extending from the caudal angle of the scapula to the tuber coxae. The basal border ascends from the olecranon region to the next to the last inter-costal space at the dorsal border.

Because of the convexity of the diaphragm, the costal pleura adjascent to the diaphragm has against the diaphragmatic pleura, with a narrow capillary space intervening which is called costo diaphragmatic recess. The diaphragmatic line of pleural reflection is the ventrocaudal limit of the costodiaphragmatic recess. It is clinically important as the caudal boundary of the pleural cavity for surgical purposes. Punctures or incisions caudoventral to this line will enter the peritoneal cavity. The

course of the line varies in different species, but in general it passes along the eight and ninth costal cartilages in the costal arch, then curves dorsally to the last rib.

Pleurocentesis for the drainage of fluids from the pleural cavity is performed at the lowest safe point in the standing animal. This is in the costomediastinal recess caudal to the pericardium and cranial to the diaphragmatic line of pleural reflection. Thus the optimum point for drainage of the pleural cavity varies slightly between the right and left sides and among species, according to the position of the heart and pleural reflection. A general role is to puncture the intercostal space somwhat dorsal to the costo chonodial junction and midway between the ribs to avoid the ventral intercostal vessels, Unlike the dorsal intercostal vessels, which hug the caudal border of the rib, the ventral ones are double and follow both cranial and caudal borders of the costal cartilage and ventral end of the bony rib.

Normal lung sounds are thought to result from the oscillation of respiratory tissue as air passes through them and from rapid fluctuations of gas pressure. They are produced by turbulent flow of air through larger airways. The minimum diameter of an airway capable of producing audible sounds is about $2mm^2$.

Thorax Horse:

The diaphragmatic line of pleural reflection is marked on the ribs. It follows the eight and ninth costal cartilages, crosses the ninth rib above the costechondral junction until it reaches the middle of the last rib, where it curves mediocranially to join the mediastinum in the vertebral end of the last intercostal space. Pleurocenthesis is done above the superficial thoracic vein in the seventh intercostal space. It is also possible to puncture the sixth space on the right side because of the more cranial position of the area of contact between the pericardium and thoracic wall.

The dorsal limit of the percussion and auscultation area is the lateral margin of the large spinal muscles, the most lateral of which terminates on the angles of the ribs. The cranial border is formed by the triceps muscle and varies with the position of the limb. In the usual standing position, the olecranon is in the exposed part of the 11th or 12th rib, to the margin of the spinal muscles in the 15th intercostal space.

Thorax Ox

The diaphragmatic line of pleural reflection, marked on the ribs, extends in a curve from the seventh or eighth costochondral junction, through the middle of the 11th rib, to the angle of the last rib, pleurocentesis may be done in the sixth or seventh intercostal space on both sides, a short distance above the costochondral junction.

The dorsal limit of the percussion area is seen at the margin of the spinal muscles. In the standing adult animal, the olecranon is about at the sternal end of the

fifth rib. The basal border of the lung runs from the costochondral junction of the sixth rib to the margin of the spinal muscles in the 11th intercostal space.

Thorax Dog and Cat:

The diaphragmatic line of pleural reflection, marked on the ribs runs from the knee (it is a bend in the costal cartilage) of the eighth rib, across the 11th rib just above its costochondral junction, to the dorsal border of the 13th rib. Pleurocentesis is performed in the seventh or eighth intercostal space in the dog and in the eighth in the cat. The long axis of the heart forms a more acute angle with the sternum in the cat than in the dog. The basal border of the lung curves from the costochondral junction of the sixth rib to the margin of the spinal muscles in the 11th intercostal space.

HORSE:

percussion:

The basal border of the lung percussion area, as determined by light, finger to finger percussion, begins at the sixth rib two finger breadths above the olecranon and runs dorsocaudally. At the tenth intercostal space the basal border intersects a dorsal plane through the shoulder joint. It may also intersect the middle of the 11th rib. At the 14th space it intersects the dorsal plane of the tuber ischiadicum. Upto this point the line is straight, then it curves strongly to the point where the 16th intercostal spae meets the back muscles.

The resonance of the normal lung decreases gradually as one approaches the basal border caudal to the dorsal third of the dorsal border of the right lung there is an abrupt change to the flat liver sound ventral to the midline of the basal border there may be resonant area caused by gas in the dorsal colon, but the resonance has lower picth than that of the lung.

Auscultation:

The normal lung sound is inspiratory. It is soft hissing, and in the resting horse it is only audible in the region close to the triceps. If the horse is exercised, the sound become lounder, and the lung may be outlined with the stethoscope.

Cow Percussion:

The bassal border of the percussion area is almost straight. It intersects the cranial border at the sixth costochondial junction. In the seventh intercostal space the basal border interesects the dorsal plane through the shoulder joint. In the 11th space the basal border meets the dorsal border at the muscles of the back.

Caudal to the dorsal thrid of the basal border of the left lung, the resonance merges into the typmpanitic sound of the upper part of the rumen, while in the dorsal thrid of the basal border of the right lung, the resonance ends abruptly at the liver on the middle third of the basal border on both sides, the resonance ends abruptly because of the injesta in the rumen and omasum.

Auscultation:

The normal sound is much louder and harsher than in the horse. It is heard on inspiration and is loudest just caudal to the triceps.

Dog and Cat:

Percussion:

The basal border of the percussion area passes from the level of the olecranon at the sixth rib through the middle of the eighth rib to intersect the dorsal border at the 11th intercostal space. The resonance is more clearly heard, in comparison with that in larger animals.

Auscultation:

Outlines the area of normal breathing sounds. They are more distinct in the axillary region and over the rest of the lateral thoracic wall.

HEART

The position of the Heart:

	Cranial extent	Caudal extent
Cat	4th Space	7th rib
Dog	3rd rib	6th space
Pig	2nd rib	5th rib
Ruminant	2nd space	5th space
Horse	2nd space	6th space

It is important to locate the fifth rib. It is usually opposite the olecranon when the limb is vertical.

On percussion of the heart, two zones are described (1) The area of the absolute cardiac dullness corresponds to the area of contact of the pericardium with the thoracic wall. It gives a flat sound on light percussion. (2) The area of relative cardiac dullness is difficult to determine in animals. It is defined by somewhat stronger percussion and indicate the outline of the heart that is covered by the thin margin of the lung. For practical purposes, the absolute dullness may be used to test for hypertorphy, displacement and pericardial effusion.

The area of absolute dullness in the horse is a right triangle bounded by the triceps in front, the sternum below, and the lung along the hypotenuse. The object of percussion is to determine wheter or not the heart is enlarged i.e whether or not the hypotenuse is displaced dorsocaudally. On the left side of the normal horse, dullness extends about 7cm above the olecranon in the fourth space and about 3cm above olecranon in the fifth space. On the right, the dullness extends about 3cms above the olecranon in the fourth space only.

In the ox, the normal area of the absolute dullness is too far cranial for percussion. The lower limits of lung reasonance in the fourth and fifth spaces should be carefully explored. Traumatic pericarditis may produce absolute dullness in these spaces, extending above a dorsal plane through the shoulder joint.

Small dogs are most easily percussed by holding them in the sitting up position and working on the ventral surface of the thorax, On the left side, the cardiac dullness extends out to the costochondral junctions in spaces four and five but not so far in six. On the right side, the dullness extends only 1 to 2 cm. from the sternum in spaces four and five.

In auscultation, the first heart sound heard in each cycle is caused by the closing of the right and left atrio ventricular valve. The second sound is caused by closing of the aortic and pulmonary valves. Systolic murmurs occur between the first and second heart sounds. Diastolic murmurs are much less common and occur after the second sound and before the first sound of the next cycle. Once it has been decided that heart murmur systolic or diastolic, it is necessary to determine which of four possible valvular conditions is the cause. The possibilities are given below.

Heart lesions and murmurs

Lesion	Time of murmur	
	Systolic	Diastolic
Stenosis	Aortic	Right AV
	Pulmonary	Left AV
	Right AV	Aortic
Insufficiency	Left AV	Pulmonary

The determination of this is mainly an anatomical problem.

By listening at the known point of maximum audibility for each valve, it may be possible to localize the murmur. The puncta maxima established for the valves do not necessarily correspond with the anatomical position of the valves.

The locations of the puncta maxima may be summerized in general terms for all species as follows:

Left Av Low in the left fifth intercostal space (fourth in the ox)

This is dorsocaudal to the Olecranon in the horse, medial to the media epicondyle in the ox at the costo-chondral joint in the dog.

Aortic: High in the left fourth space, just below a dorsal plane passing through the shoulder joint.

Pulmonary: Low in the left third space.

Right AV: Low in the right third or fourth space.

Auscultation of the individual valves of the feline heart is difficult because the total length of the heart about 4 cms is the same as the diameter of the head of the stethoscope, and the heart rate is so fast that the first and second sounds can be distinguished only by their quality rather than their timing.

The cardiac lesions that are not associated with valves also produce murmurs in certain locations. In the dog, the sound of an interventricular septal defect is heard regularly with maximum intensity on the

right. It is often accompanied by the murmur of a functional pulmonary stenosis on the left. A patent ductus arteriosis has characteristic 'machinery murmur' that increases in sysole and decreases in diastole and is loudest in the third and fourth spaces on the left.

The minimum intensity of the heartbeat is normally at the apex on the left. Valvular lesions and congenital defects may produce a palpable vibration instead of the beat, as in the left third and fourth spaces with ductus arteriosus. The intensity may be increased or the maximum intensity may be felt on the right side with enlargement or displacement of the heart.

Cardiac puncture for obtaining blood or the injection of the drug is usally done on the right side in the fourth or fifth intercostal space a few centimeters above the sternum, at about the level of the Olecranon. The thin walled right ventricle is accessible here inthe notch between the right cranial and middle lobes of the lung. Left ventricular blood is accessible through the interventricular septum. If cardiac puncture is for resuciation and is associated with cardiac massage, the left fifth intercostal space is preferred, when the puncture, will be through the thicker left ventricle, which is less likely to bleed during the massage and produce cardiac tamponade.