CHAPTER I

Introduction

The natural distribution of spotted deer (*Axis axis*) is limited to the Indian sub-continent, although successful introductions occurred elsewhere (ARC, 1980). In Bangladesh spotted deer is found throughout the Sundarban forest but the population density seems to be higher in the South and particularly concentrated in the marine grassland areas (Ables, 1977). The total population estimate of spotted deer ranges between 52,000 (Adam, 1994) and 80000 (Ables, 1977) individuals.

The world deer industry is growing about 20% annually and about five million deer's currently being farmed (Chapple *et al.,* 2003.) In 2002, the estimated deer numbers in New Zealand was 2.25 million, produce 24,400 tons of venison with 90% venison being exported to Europe, mainly to Germany (Denholm, 1984). China has the second largest farmed deer (500,000 mainly sika deer). Australia has about 200,000 animals on around 1,200 farms and red deer and fallow deer form the great majority of the herd (Deodatus and Ahmed, 2002). Other countries, such as United Kingdom (UK), Denmark and United States of America (USA), also have a significant number of deer.

To establish deer farming which is economically promissory industry for the production of venison and other by-products, there is a need to understand and develop effective ex situ management systems of spotted deer in Bangladesh. Conservation of nature and natural resources is now a global concern. Due to the severe pressures faced by the deer, the IUCN has twice listed it as an endangered species firstly in 1994 (when it was de-listed within the year) and again in 1996 (which listing has continued until the present) (IUCN, 2012).

Without proper scientific knowledge on topographic anatomy, both clinical and surgical treatment is very difficult. Though it is ruminant but it has some difference from other ruminants in topographic anatomy. Topographic anatomy is the study of anatomy based on regions or divisions of the body and emphasizing the relations between various structures in that region. Topographic position facilitates to locate and examine deeper organs. This is of importance to the surgeon who exposes different planes after the skin incision and who, of course, must be perfectly familiar with structures as he explores the limbs and body cavities.

In case of zoo animal like Spotted deer, to locate the lung area, auscultation area of heart, liver area, Spleen, reticular area of stomach it is very important for a zoo veterinarian to have sound knowledge about topographic anatomy of visceral organs of thoracic and abdominal regions.

In context of Bangladesh where Zoo animal practice is rare, so details study about it is also very few. Apart from some surveys, systematic studies have never been conducted on the topographic anatomy of spotted deer in Bangladesh. This study will be helpful for a zoo veterinarian for better understanding about anatomical structure of visceral organs of spotted deer.

Therefore, the present study was undertaken with the following objectives:

- To know the topographic anatomy of visceral organs of thoracic and abdominal region of the Spotted deer.
- To compare the macro anatomy of organs of Spotted deer with other species.
- To implement the anatomical knowledge in clinical examination for diagnose the diseases.
- To implement the anatomical knowledge in treatment and surgery in related field.

CHAPTER II

Review of Literature

2.1 Spotted deer

Spotted deer belongs to the Family Cervidae of Order Artiodactyla of the Class Mammalia of animal kingdom. Species Axis axis and genus Axis is native to all continent.

In Bangladesh spotted deer is found throughout the Sundarban forest but the population density seems to be higher in the South and particularly concentrated in the marine grassland areas (Ables, 1977). The axis deer was first introduced into Texas in the 1930s and now occurs in at least forty-five counties. Largest numbers occur on the Edwards Plateau, where the semi open, dry scrub forest vegetation resembles that of its native habitat in India (Ables *et al.*, 1977).

In their native lands, the deer occupy grasslands and very rarely move into areas of dense jungle that may occur adjacent to them. Short grasslands are an important area for them due to a lack of cover for predators such as the tiger (Moe *et al*., 1994). Therefore, the deer requires open areas as well as forested areas within their home ranges for optimum habitat (Lundrigan and Gardner, 2013). The natural distribution of spotted deer is limited to the Indian sub-continent, although successful introductions occurred elsewhere (ARC, 1980).

2.2 Topographic anatomy of visceral organs of deer

2.2.1 Stomach of deer

Deer are ruminants, or cud-chewers, and have a four-chambered stomach (Dale *et al*., 1988). Deer eat large amounts of bulky plant food in short feeding bouts; hold it in the rumen, then return to a secure place. There the food is regurgitated, chewed for a second time ("ruminating" or "chewing the cud"), returned to the rumen and then into the reticulum and omasum and finally the abomasum which is the equivalent of the human stomach. Food then moves into the small and large intestines to complete digestion. The dung deposited by deer can give some indication of the species present, their density and how they use their habitat (www.thedeerinitiative.co.uk).

2.2.2 Liver of spotted deer

Deer are somewhat unusual amongst mammals in having no gall bladder (www.thedeerinitiative.co.uk).

2.2.3 Kidneys of Spotted deer

Gross anatomical study of kidney of spotted deer revealed that both the right and left kidneys was roughly bean shaped but elongated in appearance. Lobulations were absent on surfaces. Renal crest was prominent. Both kidneys were sublumber in position. Anatomical structure of spotted deer was virtually identical to those of other domestic ruminants (Halder *et al.,* 2002)

Fat storage is one index for effective measurement of deer health due to the manner in which deer store and use body fat on an annual basis. In general, whitetails gain weight during late spring and summer, store fat during fall, and lose weight during winter and early spring. The more commonly used indicators include bone marrow and kidney fat. The amount of fat surrounding the kidneys is an indicator of abdominal fat reserves, so a kidney fat index (KFI) can also be used to evaluate the physical condition of deer. KFIs are more objective than visual assessments of bone marrow fat, and they have been used to assess nutritional status in whitetails, mule deer, elk, and several other species. (Adams, 2008)

2.3 Topographic anatomy of visceral organs of other ruminants

2.3.1 Lungs of Ruminants

On the left chest the ventral border of the left thoracic lung field of cattle extends posteriorly from a point just above the caudal border of the elbow at the 6th costochondral junction. The ventral border is demarcated by an imaginary curving line passing through the middle of the 9th rib to the most proximal part of the 11^{th} intercostal space. The dorsal border extends anteriorly from the 11^{th} intercostal space along a line just below the transverse processes of the thoracic vertebrae to the caudal musculature of the scapula and the triceps muscle. The right thoracic lung field occupies a comparable position on the right side of the thorax (Cockcroft *et al*., 2008).

2.3.2 Heart of Ruminants

The pericardium is attached by two divergent sternopericardiac ligaments to the sternum at the level of the notches for the 6^{th} costal cartilages. The fibrous pericardium is a tough, inelastic, dense irregular connective tissue sac with one end attaching to the diaphragm and the other open end fusing with the connective tissue surrounding the blood vessels entering and leaving the heart (Budras *et al*., 2003).

2.3.3 Diaphragm of Ruminants

All mammals have a muscle that separates the respiratory system (lungs) from the rest of the internal organs. This muscle is called the diaphragm. The diaphragm works with the muscles between the ribs called "intercostals" to produce inspiration (or breathing in). Exhalation (or breathing out) is muscle relaxation, causing the air to move out of the lungs and body (Edminster *et al*., 2008).

The diaphragm is a broad, unpaired muscle which forms a partition between the thoracic and abdominal cavities. The thoracic surface is strongly convex and abdominal surface is concave. On the abdominal side it is connected with liver and on the thoracic side it is connected to the heart and lungs by serous fold. The diaphragm may be divided into a lumbar, a sternal and a costal part. The lumbar part is formed by two muscular pillars, the right and left crura, the right crus attaches to the first four lumbar vertebrae, the left crus attach to the ventral longitudinal ligament of the first and second lumbar vertebrae. The sternal part is attached to the abdominal surface of the xiphoid cartilage. The costal part is attached to the ribs and eighth costal cartilage (Sisson, 1975).

The internal surface of the diaphragm is convex in shape and extends forward to the level of the 8th rib. There is an additional lung field which is located just in front of the scapula on each side of the thorax. This is called the prescapular lung field (Jackson *et al.,* 2008).

2.3.4 Stomach of Ruminants

The stomach of the ruminants is very large and it is composed of four compartments; rumen, reticulum, omasum and abomasums (Dyce *et al*., 2002).

2.3.4.1 Rumen

The rumen occupies most of the left portion of the abdominal cavity and extends over the median plane in the middle and to some extent ventrally. Its long axis reaches from a point opposite the ventral part of the7th or 8th intercostal space or 9^{th} rib almost to the pelvic inlet (May *et al*., 1970). The rumen is laterally compressed and extends from the abdominal roof to the floor and from left body wall across the midline, especially caudally and ventrally where it reaches the lowers to right flank (Dyce *et al*., 2002).

2.3.4.2 Reticulum

Reticulum located between sixth, seventh, eighth ribs the greater part of it lies on the left of the median plane. It is somewhat piriform, but is compressed craniocaudally. The diaphragmatic surface lies against the diaphragm and liver. Reticulum is in contact with the diaphragm, which in turn is in contact with the pericardium and lungs. The visceral surface is flattened more or less by the pressure of atrium ruminis. Its lesser curvature faces to the right dorsally and is connected with omasum. The greater curvature face to the left and ventrally it lies against the diaphragm, opposite the sixth and seventh ribs. The fundus of the reticulum forms a rounded cul-de-sac, which is in contact with the sternal part of the diaphragm, the liver, the omasum, and the abomasum: it is opposite to the ventral end of the intercostal space (Budras *et al*., 2003).

2.3.4.3 Omasum

In the normal adult ox the omasum is in contact with the right abdominal wall in the ventral parts of the seventh to ninth intercostals spaces, and with the abdominal floor in a small area between the xiphoid cartilage and the right costal cartilages (Budras *et al*., 2003).

2.3.4.4 Abomasum

The abomasum is an elongated sac which lies chiefly on the abdominal floor. The cranial blind end, the fundus, is in the xiphoid region in relation to the reticulum, atrium ruminis, the ventral sac of the rumen. The body extends caudally between the ventral sac of the rumen and the omasum. The parietal surface is in contact mainly with the abdominal floor, while the visceral surface is for the most part related to the rumen and omasum. The greater curvature gives attachment to the superficial wall of the greater omentum. The lesser curvature gives

attachment to the lesser omentum, which passes over the parietal surface of the omasum to the liver (Budras *et al*., 2003).

2.3.5 Liver of Ruminants

The liver reaches its adult size by the third year and after that its weight ranges from 4–10 kg depending on breed, age, and nutritional condition. The weight is relatively greater in the calf. Its color varies from yellowish in the calf to reddish-brown in the adult. Because of the enlargement of the rumen it is almost entirely displaced to the right except for a small portion ventral to the esophagus. The right lobe is caudodorsal and the left lobe is cranioventral. The thick dorsal border is almost in the median plane. Here the caudal vena cava runs in a groove inclined ventrally to the foramen venacavae. Between the caudate lobe and the left lobe is the esophageal impression distinct only in fixed livers. The acute ventral border is caudoventral on the right. The fixed specimen shows a large omasal impression and ventral to it, a reticular impression (Budras *et al.* 2003). The gallbladder is pear-shaped with a total length of 10–15 cm. It extends beyond the ventral (right) border of the liver. The right and left hepatic ducts join to form the common hepaticduct, which receives the cystic duct and becomes the short, wide common bile duct (19, ductus choledochus), which opens into the duodenum about 60 cm from the pylorus on theoblique greater duodenal papilla. Hepatocystic ducts open directly into the gall bladder (Budras *et al*., 2003).

2.3.6 Spleen of Ruminants

The spleen is relatively small, red-brown in the bull and blue gray in the cow. It is up to 50 cm long and its average weight varies with sex, age, and body size from 390 to 2000 g. It is an elongated oval, tongue-shaped organ of about equal width throughout. Its position is almost vertical. The dorsal end is near the vertebral column and the ventral end is a hand's breadth dorsal to the 7th–8th costochondral junction. The cranial and caudal borders are rounded in the bull, acute in the cow (Budras *et al*., 2003).

In cattle the spleen is flat, 40 cm in length, 9cm in width and 2 to 3 cm thick. It lies on the left side of the body with its visceral surface in contact with the dorsolateral walls of the rumen and reticulum. The parietal surface is in contact with the diaphragm. The upper extremity is level with the dorsal parts of the 12th and 13th ribs, and the lower extremity is level with the

costochondral junction of the 7th rib. It is normally not palpable, but if it is grossly enlarged it may be palpated just caudal to left rib cage (Sisson, 1975).

2.3.7 Kidneys of Ruminants

The left kidney lies beneath the 3rd to 5th lumbar vertebrae, suspended in a fold of mesentery. It is pushed towards the midline or to the right of the midline by the dorsal wall of the distended rumen (Fig. 9.1). The right kidney lies beneath the 12th thoracic to the 3rd lumbar vertebrae and is immediately in front of the left kidney. Both kidneys are lobulated and are not normally palpable through the body wall. The caudal pole of the left kidney is palpable. (Sisson, 1975).

CHAPTER-III

Materials and methods

An adult male Spotted Deer *(Axis axis)* was brought in Sahedul Alam Quadery teaching veterinary hospital, Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh for surgical treatment. History revealed that it was a wild spotted deer and during seeking of feedstuffs, local inhabitants of Raozan area, Chittagong, hit it by bamboo stick with an intention to slaughter it for consumption. Upazila Livestock Officer of Raozan office, Chittagong have rescued and hospitalized it. Thorough examination found the deer injured in different body regions with severe multiple left metatarsal fractures. It was treated well but died after four days of treatment. Before post mortem examination species name, tentative age, body weight, body length, external features were recorded in hospital case record sheet. It was then allowed to anatomical study followed by post mortem examination in Anatomy laboratory of the same university. Keeping in dorsal recumbancy, a longitudinal incision was made at the ventral midline from pharynx to the pelvic inlet to remove the skin. Then it was kept in lateral recumbancy and the limbs, muscles were removed carefully without any damage the rib cage. Then the intercostal muscles were removed to easy visualize the topographic position of the organs of thoracic cavity. Subsequently the diaphragm and muscles of lateral abdominal wall was removed to identify the relative position of visceral organs of abdominal cavity sequentially without any damage or distortion. Different views were examined to describe the organs. Length of the respective organ was measured by a calibrated scale placing on along the long axis of the organ. To describe the position of some organs, red threads were used to encircle the area.

Photograph 01: Skinning of spotted deer keeping at dorsal recumbancy

CHAPTER IV

Results

4.1 Organs of thoracic cavity

4.1.1 Left and right lung

Left and right lung were 25 cm and 29 long respectively. Apical lobe of left lung extended upto second intercostal space whereas apical lobe of right lung extended upto the level of second rib. Diaphragmatic lobe was located up to the base of 11^{th} rib and its ventral part was at the level of costochondral junction of 7^{th} rib. But in case of right lung, diaphragmatic lobe was located up to the base of 11^{th} rib and its ventral part was at the level of costochondral junction of 7^{th} rib.

4.1.2 Heart

Apex was at the level of 6^{th} costochondral junction and base extended from mid of 3^{rd} intercostals space to level of cranial border of 6^{th} rib. Pericardium was attached in two sites, one was with the sternum by sternopericardial ligament and another was phrenopericardial ligament.

4.2 Diaphragm

Diaphragm was dome shaped attached with xiphoid process at the level of 7^{th} rib. Laterally at the level of costochondral junction upto 10^{th} rib and then from 11^{th} rib it attached mid of ribs upto 13^{th} rib. Dorsally it was attached with sublumber muscles by two crura of diaphragm at the level of ventral to the 1^{st} lumbar transverse process.

4.3 Organs of Abdominal cavity

4.3.1 Compound Stomach

Rumen: Rumen was extended from 7^{th} intercostals space to the level of coxal tuber.

Reticulum: Reticulum was located cranial to the rumen between the level of 6^{th} and 8^{th} ribs.

Omasum: It was bean shaped organ situated at the level between 7^{th} and 11^{th} rib at the right side of the median plane.

Abomasum: It lies on the abdominal floor dorsal to the xiphoid process.

4.3.2 Liver

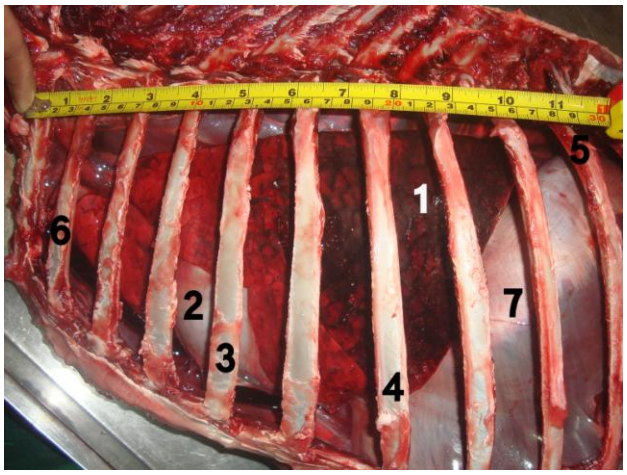
Liver was directed obliquely and cranioventrally. Its maximum length was 26 cm measured from caudate lobe to cranial border of left lobe. Maximum width was 15 cm. Its dorsal border was extended from the lumbocostal angle to the level of 7^{th} costochondral junction and ventral border was at the level of costochondral junction of last rib to 7^{th} rib.

4.3.3 Spleen

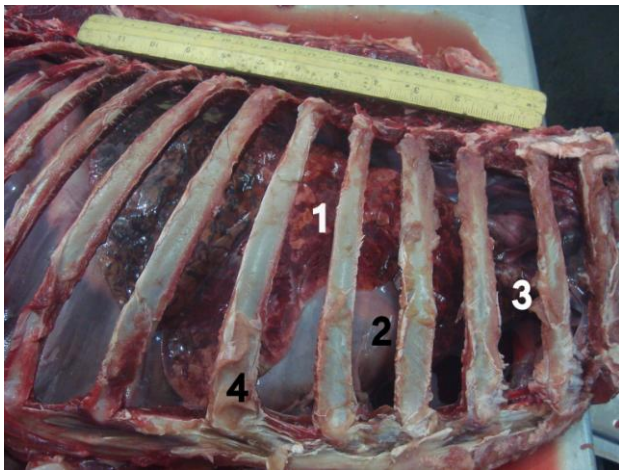
Spleen was large, elliptical in shape located on the dorsal surface of the rumen obliquely in cranioventral direction. It was extended from distal third of 8^{th} intercostals space to the proximal part of 11^{th} intercostals space.

4.4 Left and right kidneys

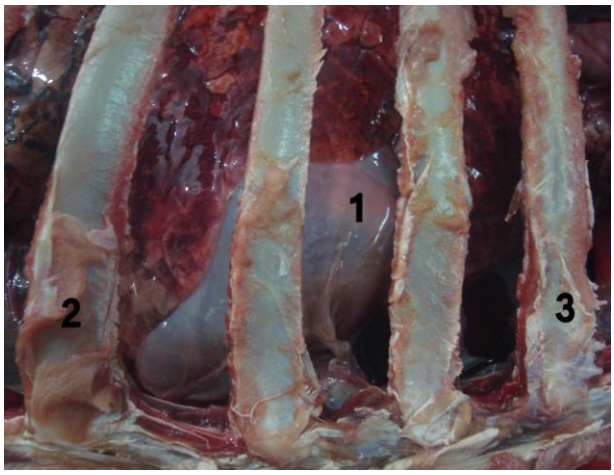
Right kidney was located below the 1^{st}, 2^{nd} and 3^{rd} lumber transverse processes. But the left kidney was located dorsal to the rumen below the sublumbar muscles extended from the level of 2^{nd} lumbar transverse process to the 4^{th} lumbar transverse process.



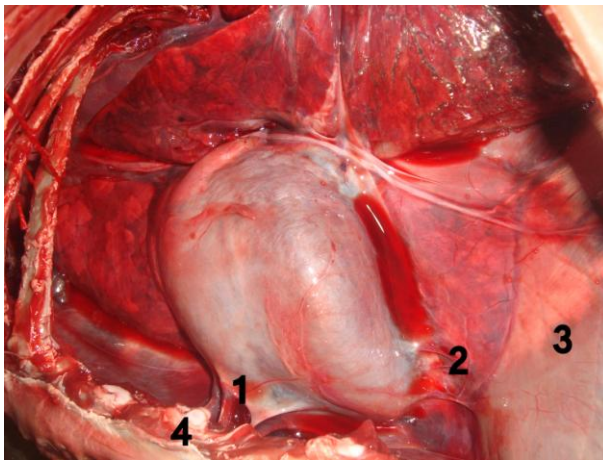
Photograph 2: Topographic position of Left Lung 1.Left lung, 2.Heart, 3. 5th rib, 4. 7th rib, 5. 10th rib, 6. 2nd rib, 7. Diaphragm



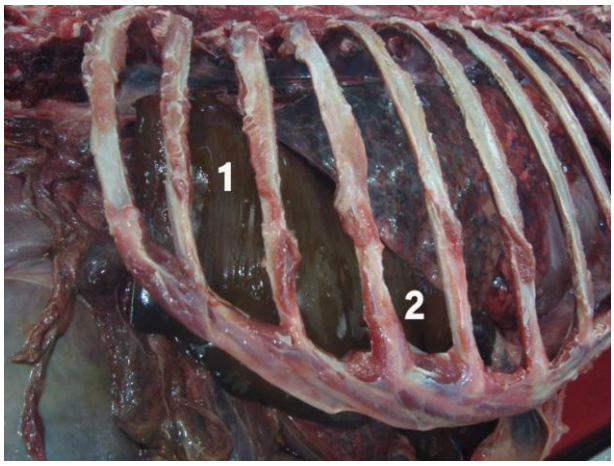
Photograph 3: Topographic position of Right lung 1.Right lung, 2. Heart, 3. 2nd rib, 4. 6th rib



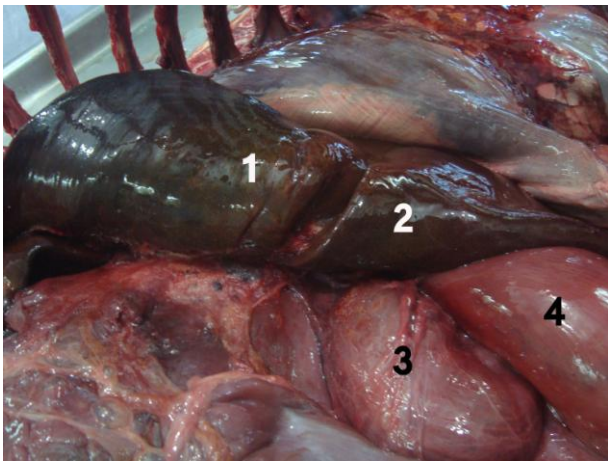
Photograph 4: Relative position of lung and Heart in the thoracic cavity. 1. Heart, 2. 6th rib, 3. 3rd rib



Photograph 5: Pericardial attachment 1. Sternopericardial ligament 2.Phrenicopericardial ligament 3. Diaphragm 4. Sternum

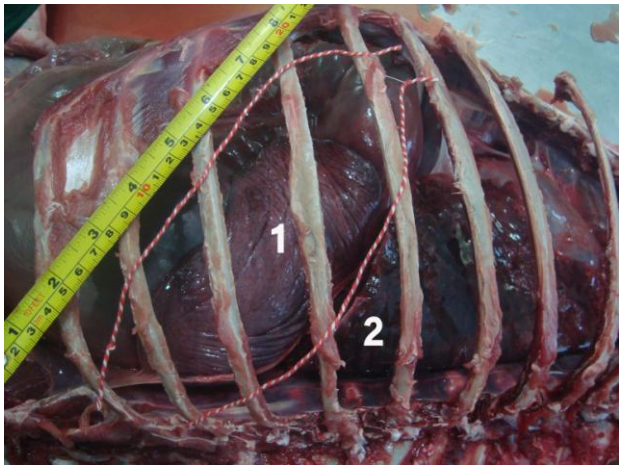


Photograph 6: Red line indicating the Liver area 1. Right lobe 2. Left lobe of liver



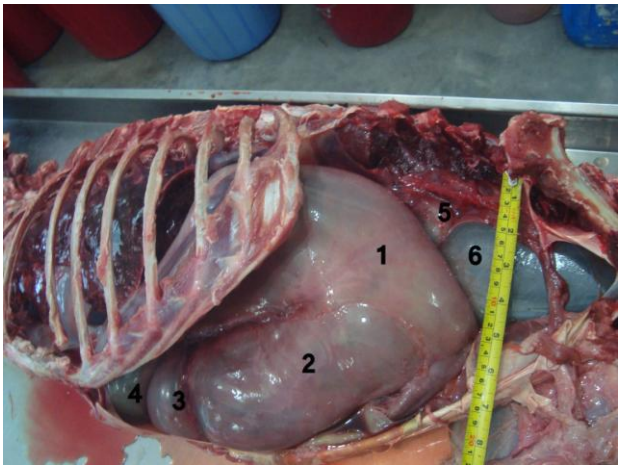
Photograph 7: Visceral surface of liver (gall bladder absent)

1. Visceral surface of right lobe 2. Visceral surface of left lobe 3. Omasum 4. Abomasum



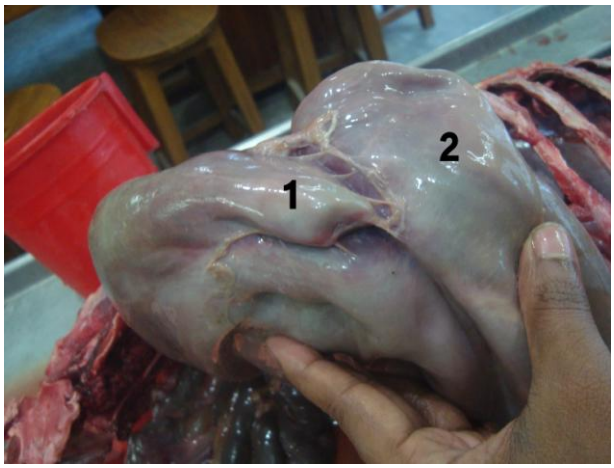
Photograph 8: Position of spleen

1. Spleen 2. Left lung



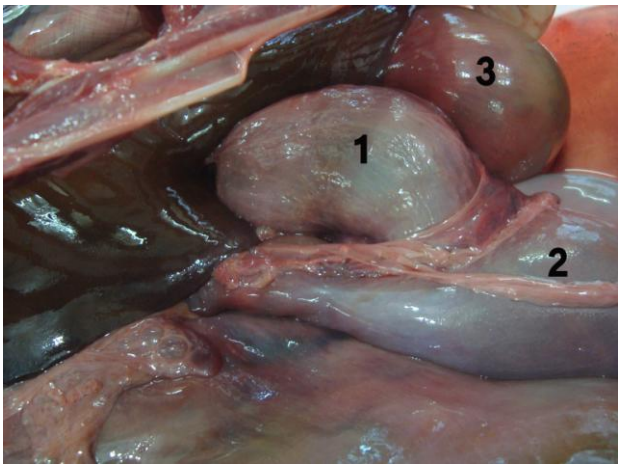
Photograph 9: Position of Reticulum, Omasum and abomasum

1. Dorsal sac of rumen 2. Ventral sac of rumen 3. Abomasum 4. Reticulum 5. Left kidney 6. Urinary bladder



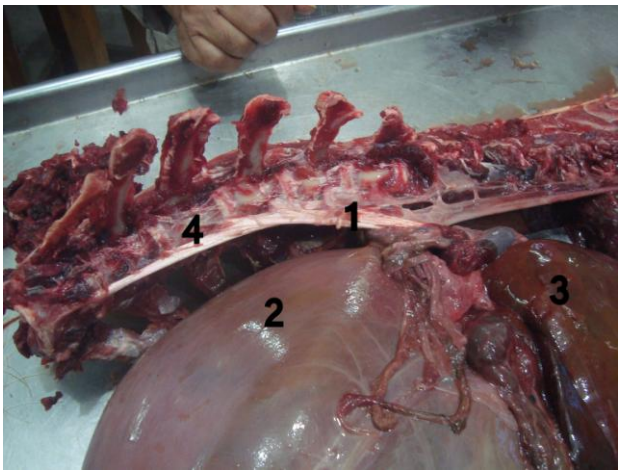
Photograph 10: Small pouch of dorsal sac of rumen

1. Small pouch of dorsal sac 2. Ventral sac



Photograph 11: Bean shaped omasum

1. Omasum 2. Abomasum 3. Reticulum.



Photograph 12: Crural attachment of diaphragm 1. Crura of diaphragm 2. Rumen 3. Liver 4. Crural attachment

CHAPTER V

Discussion

5.1 Organs of thoracic cavity

5.1.1 Lungs

This study revealed that left lung of spotted deer was 25 cm long. Apical lobe was extended at the dorsal part of middle of second intercostal space. Diaphragmatic lobe was located up to the base of 11^{th} rib and its ventral part is at the level of costochondral junction of 7^{th} rib. Jackson *et al* (2008) showed that, the ventral border of left lung of ruminant was demarcated by an imaginary curving line passing through the middle of the 9th rib to the most proximal part of the 11^{th} intercostal space. The dorsal border extended anteriorly from the 11^{th} intercostal space along a line just below the transverse processes of the thoracic vertebrae to the caudal musculature of the scapula and the triceps muscle. The right thoracic lung field occupied a comparable position on the right side of the thorax.

Miller *et al* (1964) showed that in a 22 pound dog it was 10 cm long, 3cm wide, and 1 cm thick. It extends from the dorsal part of the fifth rib to and through the thoracic inlet, where its apex lies not only cranial to a larger plane but also largely to the right of the median plane. The apical lobe of the left lung was transversely compressed between heart and the lateral thoracic wall. Its cauudal margin may lied medial or lateral to the caudally lying cardiac lobe. The cardiac lobe of the left lung presented a thin dorsocranially convex border which overlied the caudal thickened portion of the apical lobe. The diaphragmatic lobe of the left lung extended from the costal surface to the root of the lung. The right lung is similar to the left lung, but lying about 1 cm. further caudad.

5.1.2 Heart

This study showed that pericardium was attached in two sites one is with the stenum by sternopericardial ligament and another is phrenecopericardial ligament. Budras *et al.,* (2003) stated that, the pericardium was attached by two divergent sternopericardiac ligaments to the sternum at the level of the notches for the 6^{th} costal cartilages. Evans, (2010) stated that, in dog the heart and pericardium were located in the middle part of the mediastinum from the

level of the third to the sixth rib. The continuation of the fibrous pericardium to the sternum and diaphragm formed the phrenicopericardial ligament.

5.2 Diaphragm

This study showed that, the diaphragm was dome shaped attached with xiphoid process at the level of 7th rib laterally at the level of costochondral junction upto 10th rib and then from 11th rib it attached mid of ribs up to 13th rib**.** Jackson *et al., (*2008) found that in ruminant the internal surface of the diaphragm is convex in shape and extended forward to the level of the 8th rib. This study also showed that, dorsally it was attached with sublumber muscle by two crura of diaphragm at the level of ventral to the 1st lumbar transverse process. In another study Sisson, (1975) found that in ruminant, the diaphragm may be divided into a lumbar, a sternal and a costal part. The lumbar part is formed by two muscular pillars, the right and left crura, the right crus attaches to the first four lumbar vertebrae, the left crus attach to the ventral longitudinal ligament of the first and second lumbar vertebrae. The sternal part is attached to the abdominal surface of the xiphoid cartilage. The costal part is attached to the ribs and eighth costal cartilage

5.3 Organs of Abdominal cavity

5.3.1 Compound Stomach

Rumen

This study showed that, the rumen of Spotted deer extended from 7th intercostals space to the level of coxal tuber. May *et al*., (1970) showed that, in ruminant the rumen occupies most of the left portion of the abdominal cavity and extended over the median plane in the middle and to some extent ventrally. Its long axis reached from a point opposite the ventral part of the7th or 8th intercostal space or 9th rib almost to the pelvic inlet. Habel *et al*., (1975) showed that the ventral sac of rumen of Sheep and goat extended more to the right of the median plane than in the ox.

Reticulum

This study showed that, the reticulum located cranial to the rumen between the level of 6th and 8th ribs. Habel *et al., (*1975) stated that, reticulum of cattle located between sixth,

seventh, eighth ribs. the greater part of it lied on the left of the median plane. it was somewhat piriform,but was compressed craniocaudally. The diaphragmatic surface lied against the diaphragm and liver. reticulum was in contact with the diaphragm, which in turn was in contact with the pericardium and lungs and the reticulum of sheep and goat was relatively larger than in the ox. Its ventral part curved more caudally and less to the right than in the ox.

Omasum

This study showed that, omasum was bean shaped and situated at the level between 7^{th} and 11^{th} rib at the right side of the median plane. Habel *et al*., (1975) stated that, in the normal adult ox the omasum was ellipsoidal in form and is in contact with the right abdominal wall in the ventral parts of the seventh to ninth intercostals spaces, and with the abdominal floor in a small area between the xiphoid cartilage and the right costal cartilages and the omasum of sheep and goat was oval shaped and located entirely on the median plane, opposite the ninth and tenth ribs.

Abomasum

This study showed that, the abomasum lied on the abdominal floor dorsal to the xiphoid process. Habel *et al*., (1975) stated that, the abomasum is an elongated sac which lies chiefly on the abdominal floor.

5.3.2 Spleen

This study showed that, spleen was large, elliptical in shape located on the dorsal surface of the rumen obliquely in cranioventral direction. It was extended from distal third of 8^{th} intercostals space to the proximal part of 11^{th} intercostals space. Sisson, (1975) stated that, in cattle the spleen was flat, 40 cm in length, 9cm in width and 2 to 3 cm thick. The upper extremity was in level with the dorsal parts of the 12th and 13th ribs, and the lower extremity is level with the costochondral junction of the 7th rib and in sheep and goat,the spleen was approximately 100 gm and length is about 12 to 15 cm and wisth is about 7.5 to 10 cm. The long axis was oblique and correesponds to a line drawn from the vertebral end of the last rib to about the middle of the tenth intercostal space.

5.4 Kidney

This study showed that Left kidney was located dorsal to the rumen below the sublumbar muscle extended from the level of 2nd lumbar transverse process to the 4th lumbar transverse process. Right kidney was located below the 1st, 2nd and 3rd lumber transverse processes. Gross anatomical study of kidney of spotted deer by Mahata and Bhattacharjya, (2002) revealed that both the right and left kidneys were roughly bean shaped but elongated in appearance. Both kidneys were sublumber in position. Sisson, (1975) stated that, the left kidney of ruminant lied beneath the 3rd to 5th lumbar vertebrae, suspended in a fold of mesentery. It was pushed towards the midline or to the right of the midline by the dorsal wall of the distended rumen. The right kidney lied beneath the 12th thoracic to the 3rd lumbar vertebrae and was immediately in front of the left kidney.

CHAPTER VI

Conclusion

It could be concluded from the topographic study of thoracic and abdominal organs of Spotted deer showed that, it has some difference from other mammals as well as other ruminants. Such as attachment of pericardium with sternum by two ligament sternopericardiac and phrenicopericardiac, absence of gallbladder, difference in location, size, shape of organs. This will help the Zoo veterinarian to diagnose specific disease, to identify the most appropriate treatment and also make an important contribution to the economy by preventing unnecessary operations and demonstrating a positive approach to animal well-being.

Recommendations

The study suggests following recommendations-

1. Ultrasonographic study may play a role to identify topographic relationship in live sample.
2. Further detail examination with more sample may be needed to obtain a specific anatomical knowledge.

Limitations

The study has following constraints-

1. Single sample was studied but for detail knowledge more sample is needed.

2. Length, width of all related organs was not studied.

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