

DIAPHRAGMATIC HERNIA

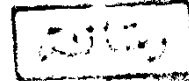
An Essay Submitted for Partial Fulfillment of
MASTER DEGREE IN GENERAL SURGERY

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INDEX

Chapter 1: Embryology of The Diaphragm	1
Chapter 2: Anatomy of The Diaphragm	7
Chapter 3: Congenital Diaphragmatic Hernia	22
Chapter 4: Acquired Diaphragmatic Hernia	46
Chapter 5: Management of Diaphragmatic Hernia	128
Chapter 6: Summary	152
Chapter 7: References	157
Chapter 8: Arabic Summary	

LIST OF FIGURES

Figure 1: Diagrammatic Representation of Type II (Para-oesophageal) Hernia	25
Figure 2: Diagrammatic Representation of Type I (Axial or Sliding) Hernia	52
Figure 3: Laparoscopic Nissen's Fundoplication	77
Figure 4: Abdominal Repair of Oesophageal Hiatus Hernia	104
Figure 5: Belsey Mark IV Repair (Transthoracic)	108
Figure 6: Hill Posterior Gastropexy	111
Figure 7: Technique of Insertion of Angelchick Prosthesis	115
Figure 8: Collis Gastroplasty	127
Figure 9: Intrauterine Repair of Congenital Diaphragmatic Hernia	142

EMBRYOLOGY OF THE DIAPHRAGM

The formation of the diaphragm takes place between the fourth and eighth weeks of embryonic life. The diaphragm, heart, and the pericardium are formed in the neck and obtain their innervation from cervical segments 3,4, and 5. They migrate to their ultimate destination carrying their nerve supply with them (*Decker et al., 1986*).

During the fourth week of gestation, the intraembryonic coelom starts to divide and forms the different body cavities: the pericardial, pleural and peritoneal cavities through the development of mesodermal partition to occupy the position of the future diaphragm in the adult (*Warwick et al., 1975*).

The diaphragm develops from four structures:

1. Septum transversum.
2. Pleuro-peritoneal membrane.
3. Dorsal mesentery.
4. Body wall.

SEPTUM TRANSVERSUM

It is a mass of mesoderm that lies between the pleuro-pericardial cavity and the peritoneal cavity. It is formed by the fusion of the myotomes of third, fourth, and fifth cervical segments in the neck. It pulls its motor nerve supply with it, while pushed caudally by the descending heart from the neck to the thorax. It is an incomplete septum, since the pleuro-peritoneal canal lies posterolaterally on each side.

Following the descent of the septum with the heart into the thoracic cavity. It comes to project horizontally posteriorly from the anterior or central body wall to meet the dorsal mesentery. The septum transversum now becomes separated into three layers: the superior, middle and inferior layers.

The superior layer:

Helps to form the fibrous pericardium.

The middle layer:

Which forms all the muscles of the diaphragm, the central tendon and the central areas of the pleura and peritoneum covering the diaphragm.

The inferior layer:

Which forms the fibrous capsule and connective tissue of the liver and central mesentery of the developing gut (*Snell, 1975*).

In the center of the diaphragm, the central tendon remains fused with fibrous pericardium, while in the periphery they are separated by the enlarged pleural cavities. The fibrous capsule of the liver is separated from the diaphragm by the enlarged peritoneal cavity except in areas of mesenchyme, which become the falciform ligament, the right and left triangular ligament, and the coronary ligaments (*Snell, 1975*).

PLEURO-PERITONEAL MEMBRANE

This membrane fuses with the septum transversum anterior to the oesophagus and the dorsal mesentery posterior to the oesophagus by growing medially from the body wall and encroaching on the pleuro-peritoneal canal.

During fusion, the mesoderm of the septum transversum extends to the other parts, thus forming the entire muscle of the diaphragm (*Snell, 1975*).

DORSAL MESENTERY

The median portion of the diaphragm is formed from the dorsal mesentery of the oesophagus. The crura of the diaphragm develop from muscle fibers which grow into the dorsal mesentery of the oesophagus. They form an arch which overlies the aorta. The crura are sometimes referred to as the aortic component of the diaphragm (*Decker et al., 1986*).

THE BODY WALL

The lateral body wall is burrowed by the enlarging lungs and pleural cavities, and is split into two layers: an outer layer which will form part of the definitive body wall, and an inner layer that contributes to the peripheral portion of the diaphragm (*Decker et al., 1986*).

CONGENITAL ANOMALIES THAT CAN LEAD TO CONGENITAL DIAPHRAGMATIC HERNIA

Hernia through the pleuro-peritoneal canal (Bochdaleck hernia):

Most cases occur without hernial sac as the canal remains opened, and there is a free communication between the pleural and

abdominal cavity. Few cases occur with a hernial sac when the canal is closed by a layer of peritoneum and pleura (*Snell, 1975*).

Hernia through the space between the sternal and costal origin of the muscle of the diaphragm (Morgagni's hernia):

These spaces allow a small hernial sac of the peritoneum and pleura, to protrude into the thorax and may contain loops of small intestine, where there is a part of the muscle of the diaphragm that fails to develop from the septum transversum (*Snell, 1975*).

Congenital para-oesophageal or Rolling hernia:

The anterior wall of the stomach rolls upwards in a hernial sac through a defect anterior and to the right of the oesophagus, until it may be upside down in the posterior mediastinum. An important criteria of this hernia is that the normal relationship of the cardio-oesophageal junction to the diaphragm is undisturbed.

There are two theories about the origin of this hernia:

- The first one proposes that the posterior mediastinum contains a peritoneal process and the developing stomach invaginates the peritoneum from behind.

- The second theory supposes that there is a widening in the oesophageal hiatus allowing the stomach to herniate into a sac to the right of the oesophagus due to congenital defect in the right crus of the diaphragm.

This type of hernia is rare and the only way it can disturb the mechanism of the oesophagus is by its bulk compressing the oesophagus against the vertebral column (*Decker et al., 1986*).

Eventration of the diaphragm:

The diaphragm in these cases is formed from a fibrous sheet covered superiorly by the pleura and inferiorly by the peritoneum, due to a defect in the developing muscle of the diaphragm which is immobile and is pushed into the thorax at a level higher than normal (*Snell, 1975*).

ANATOMY OF THE DIAPHRAGM

Viewed from the front, the diaphragm curves up into right and left dome. The right dome is higher than the left ascending in full expiration. To the level of the nipple (fourth space), while the left dome reaches the fifth rib. The central tendon is in level with the lower end of the sternum (sixth space). Viewed from the side, the profile of the diaphragm resembles an inverted J, the long limb extending up from the crura (upper lumbar vertebra), and the short limb attached to the xiphisternum.

Viewed from above, the outline is kidney, shaped in conformity with the oval outline of the body wall which is indented posteriorly by the vertebral column (*Last, 1990*).

The diaphragm is attached in front and at the sides to the xiphoid process of the sternum, and to the lower six costal cartilages, and is attached behind to the vertebral column. It has, therefore, three origins: sternal, costal and vertebral.

1. Sternal origin: by two fleshy slips from the back of the xiphoid process.

2. Costal origin by fleshy slips from the near surface of the lower six costal cartilages, interdigitating with the slips of origin of the transversus abdominis muscle.

3. Vertebral origin: from the upper two or three lumbar vertebrae by two strong muscular crura or legs, right and left and five arcuate ligaments: one media, two medial and two lateral.

The right crus arises from the bodies of the upper three lumbar vertebrae. The left crus arises from the bodies of the upper two lumbar vertebrae.

The single median arcuate ligament is a tendinous arch which connects the right and left crura in front of the descending aorta at the level of the lower border of twelfth thoracic vertebra. The median arcuate ligament forms the aortic opening of the diaphragm. Actually, the aorta passes behind the diaphragm, and is protected from the contraction of its muscular fibers by the median arcuate ligament.

Each medial arcuate ligament forms a tendinous arch which connects its corresponding crus of the diaphragm with the tip of the transverse process of the first or second lumbar vertebra with the last twelfth rib in front of the quadratus lumborum muscle.

The two medial and two lateral arcuate ligaments are to be considered as special thickening of the fascia covering the psoas major and quadratus lumborum muscles respectively.

The muscular fibers of the diaphragm ascend from their origin (Sternal, costal, and vertebral) upwards and inwards and converge to be inserted into the central tendon.

THE CENTRAL TENDON

It is shaped like a rounded pear, or more likely crescentic in shape with its convexity forwards, placed nearer the front than the back, and is fused on each side with a similar leaf that extends back towards the paravertebral gutter. The tendon consists of interlacing fibers, and is inseparable from fibrous pericardium with which it is embryologically identical. Near the junction of the central and the right leaf, it is pierced by a foramen, the caval opening to which the

adventitial wall of the inferior vena cava is very strongly attached
(Last, 1990).

FORAMINA IN THE DIAPHRAGM

Many structures have to pass between the thorax and abdomen, and they have to pass through large openings and small holes in the diaphragm. There are three large (main) openings: aortic, oesophageal, and the vena caval, together with many smaller openings.

Aortic opening

Lies nearly in the “ middle line”, behind the median arcuate ligament at the level of the twelfth thoracic vertebra. It transmits three structures: the descending aorta, azygous vein and the thoracic duct, and lymphatic vessels which descend to the cisterna chyli from the aorta.

Oesophageal opening

Lies about one inch to the left of the middle line in the fleshy fibers of the left crus at the level of the tenth thoracic vertebra, but a