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Review

Anatomy Section

Mediastinum Anatomy: Radiological Identification (New Model)

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ABSTRACT

Section of the mediastinum into compartments is used to defining the localisation of mediastinal structures, solution at the differential diagnosis of newly found mediastinal masses, to help in planning biopsy and surgical procedures, and to simplify communication among clinicians of multiple disciplines. There are many mediastinal anatomy models in the literature, leading to confusion when defining the mediastinal anatomy. The aim is to reveal this mixed situation and propose a solution.

We divided the mediastinum into three compartments with the lines that look like meridians from the thoracic entrance to the diaphragm. Every compartment was divided into three sub-compartments into each compartment lying in the sternum from the 4-5 and 7-8 thoracal intervertebral disk-level parallel planes using the CT-based mediastinal Compartment (C) model. The mediastinum was divided into 9 compartments with meridians, similar lines, and parallel planes.

We hope that this definition can facilitate the description of locations and relations within the mediastinal anatomical structure as well as pathologies. It will also be a first step toward providing a standard for mediastinal anatomy.

Keywords: Compartment, Computed tomography, intervertebral disk, Thoracic entrance

INTRODUCTION

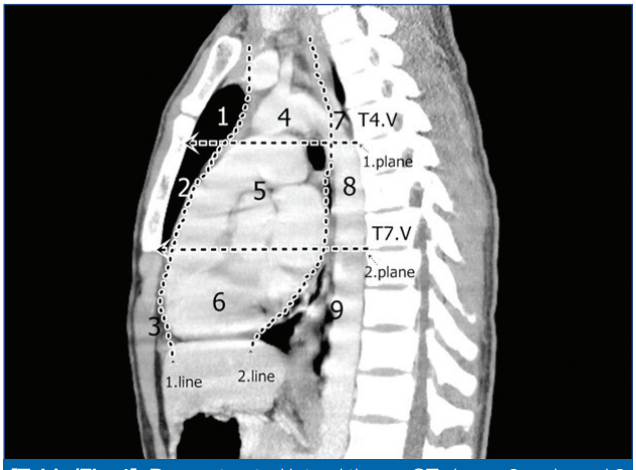
The mediastinum is a complex region that is variously subdivided by radiologists, surgeons and anatomists.

There are different opinions that divide mediastinum into three, four or six compartments. Surgeons and anatomists prefer 4 or 6-zone anatomy while radiologists prefer 3-zone for mediastinum. Also, there is no consensus among the authors about the boundaries of the compartments.

As a result many researchers have proposed alternative models for the mediastinum in the literature [1-11] few defended four compartment models [1-4,9] while some authors have suggested three-compartment models [5,7,8,10,11]. Heitzman ER et al., separated the mediastinum into six anatomical regions [6]. As shown, there is no consensus on modelling the mediastinum. It is therefore clear that there is a need for an easier and standardised mediastinal anatomy model.

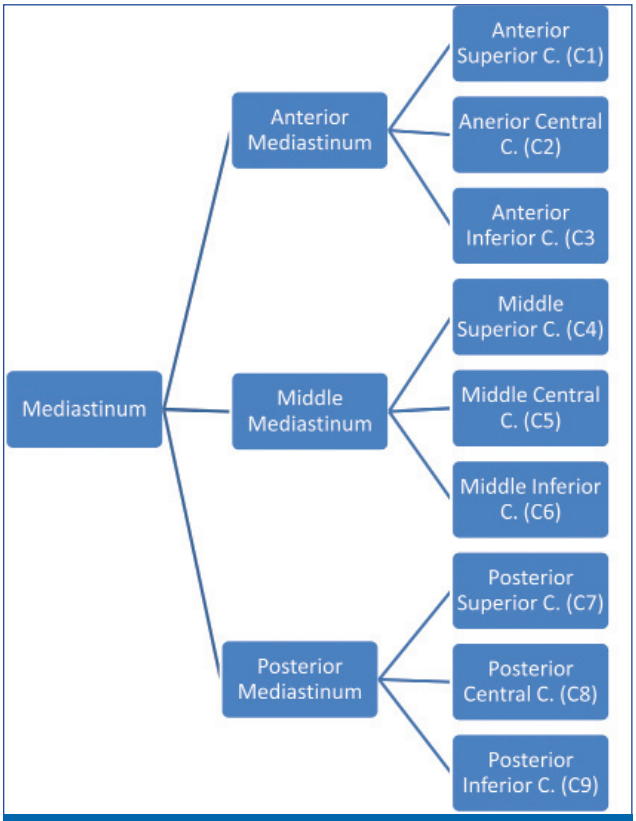
Technique

The mediastinum is separated into 3 compartments by lines that look like meridians from the thoracic entrance to the diaphragm, and every compartment is separated into three subcompartments with parallel planes [Table/Fig-1]. It has been assumed that the meridian-like lines reach to the diaphragm, starting through the thoracic entrance (the prevascular area (line 1) and retrovascular area (line 2). Then, to create approximately equal intervals, it is also assumed that the parallel planes reach the sternum perpendicularly from the intervertebral disk level T4-T5 (plane 1) and from the intervertebral disk level T7-T8 (plane 2), respectively. The first parallel plane passes through the area adjacent to the arcus aorta's lower face, and the second parallel plane passes approximately through the aortic



[Table/Fig-1]: Reconstructed lateral thorax CT shows 3 main and 9 sub compartments of the mediastinum.
Abbreviations: C, Compartment; T, Thoracic; V, Vertebrae. 1. Anterior superior C., 2. Anterior Central C, 3. Anterior Inferior C, 4. Middle Superior C., 5. Middle Central C, 6. Middle Inferior C, 7. Posterior Superior C., 8. Posterior Central C, 9. Posterior Inferior C.

valve level. In this way, every compartment is divided into three sub compartments, so that the mediastinum is divided into a total of 9 compartments. The first 3 sub compartments are C1, C2 and C3, which form the anterior mediastinum; the second 3 sub compartments are C4, C5 and C6, which form the middle mediastinum; and the final 3 sub-compartments are C7, C8 and C9, which form the posterior mediastinum. Viz: anterior superior compartment (C1), anterior central compartment (C2), anterior inferior compartment (C3), middle superior compartment (C4), middle central compartment (C5), middle inferior compartment (C6), posterior superior compartment (C7), posterior central compartment (C8), and posterior inferior compartment (C9) [Table/Fig-2].



[Table/Fig-2]: Main compartments and sub compartments of the mediastinum.
Abbreviations: C, compartment.

The anterior mediastinum is bounded anteriorly by the sternum; posteriorly by the pericardium, aorta and brachiocephalic vessels; superiorly by the thoracic inlet; and inferiorly by the diaphragm. C1's contents include the thymus, lymph nodes, adipose tissue, and internal mammary vessels. C2's contents include lymph nodes and adipose tissue. C3's contents include lymph nodes and adipose tissue.

The middle mediastinum is bounded anteriorly by the pericardium, aorta and brachiocephalic vessels; posteriorly by the pericardium and posterior tracheal wall; superiorly by the thoracic inlet; and inferiorly by the diaphragm. C4's contents include the transverse aorta; the brachiocephalic vessels; the trachea; lymph nodes; and the phrenic, vagus, and recurrent laryngeal nerves. C5's contents include the right and left atrium, the pericardium, the ascending and superior vena cava, the pulmonary vessels, the carina and main bronchia lymph nodes, and the phrenic and vagus nerves. C6 contains the right and left ventricle, the pericardium, the inferior vena cava, lymph nodes, and the phrenic and vagus nerves.

The posterior mediastinum is bounded anteriorly by the posterior trachea and pericardium, inferiorly by the diaphragm, posteriorly by the vertebral column, and superiorly by the thoracic inlet. C7's contents include the proximal segment of the esophagus, the proximal segments of the azygos and hemiazygos veins, the proximal segment of the thoracic duct, the proximal segment of the vagus and splanchnic nerves, lymph nodes and fat. C8's contents include the central segment of the oesophagus, the proximal segment of the descending aorta, the central segments of the azygos and hemiazygos veins, the central segment of the thoracic duct, the central segments of the vagus and splanchnic nerves, lymph nodes and fat. C9's contents include the distal segment of the esophagus, the distal segment of the descending aorta, the distal segments of the azygos and hemiazygos veins, the distal segment of the thoracic duct, the distal segments of the vagus and splanchnic nerves, lymph nodes and fat.

DISCUSSION

Anatomists described the mediastinum as lying between the right and left pleura in and near the median sagittal plane of the chest [4]. It extends from the sternum in front to the vertebral column behind it and include all of the thoracic viscera apart from the lungs. For descriptive purposes, it can be divided into 2 parts: the superior mediastinum, which is the upper portion above the upper level of the pericardium and the lower portion below the upper level of the pericardium. This lower portion is again subdivided into three parts: the anterior mediastinum, in front of the pericardium; the middle mediastinum, which contains the pericardium and its contents; and the posterior mediastinum, behind the pericardium. The superior mediastinum is bounded below by a slightly oblique plane passing backward from the junction of the manubrium and the body of the sternum to the lower part of the body of the T4 vertebra, and laterally by the pleura. Some authors divided the mediastinum into 4 compartments in total as shown above [1-4,9].

The Felson's method of division from 1969 is based on findings in the lateral chest film, and the mediastinum is divided into 3 compartments [5]. The anterior mediastinum is bounded anteriorly by the sternum and posteriorly by a line extending from the thoracic inlet to the diaphragm along the anterior aspect of the trachea and the back of the heart. The middle

mediastinum is bounded anteriorly by this line and posteriorly by a line that connects points 1 cm behind the anterior margins of the vertebral bodies. The posterior mediastinum is localized between the line that connects points 1 cm behind the anterior margins of the vertebral bodies and the posterior thoracic wall [5].

Later on, in 1977, Heitzman ER et al., separated the mediastinum into six anatomical regions, namely (1) the thoracic inlet, (2) the anterior mediastinum, (3) the supra-aortic area, (4) the infra-aortic area, (5) the supra-azygos area, and (6) the infra-azygos area [6].

With the introduction of bodily assessment by cross-sectional imaging technologies such as CT and MRI, several inadequacies have been identified in the classic view of the mediastinum's anatomy, which was determined using lateral chest X-ray graphs. On CT scanning, the mediastinum is composed of 300-400 cross-sections that are each approximately 1 mm thick, which makes it difficult to identify the anatomical structures and lesions in the mediastinum.

In order to compensate for this incompleteness, Zylak CJ et al., defined the mediastinum as comprising 3 compartments using transverse CT sections: (1) the anterior, (2) middle, and (3) posterior mediastinum [7]. He identified these compartments by using the assumed lines that pass through the thoracic entrance to the diaphragm. Zylak CJ et al., identified the trachea in the posterior mediastinum [7]. In 2007, much like Zylak CJ et al., [7], Whitten CR et al., defined the mediastinum as having 3 compartments: (1) the anterior, (2) middle and (3) posterior [8]. Whitten CR et al., [8] located the trachea in the middle mediastinum, which is different than Zylak CJ et al., [7]. Fujimoto K et al., suggested the following 4 mediastinal compartments based on transverse CT images: the superior section of the mediastinum, anterior mediastinum (prevascular zone), middle mediastinum (peri-tracheoesophageal zone), and posterior mediastinum (paravertebral zone) [9].

Also, Carter BW et al., proposed an alternative 3-compartment model that accepts only the paravertebral area as the posterior mediastinum and locates the trachea, descending aorta, and esophagus in the middle mediastinum [10,11].

As seen above, there is no consensus on the number or the borders of the parts of the mediastinum. Also, identifying the locations of the mediastinal structures and their pathologies using CT and MRI scans of the thorax can be confusing. For instance, a paraesophageal hernia was located in the middle mediastinum [10,11] model and in the posterior mediastinum according to Whitten et al., [8] model. Furthermore, a prevascular thymic lesion is found in the superior mediastinum according to four compartment models [1-4,9] and in the anterior mediastinum model [8].

Given the above features, a consensus seems to be needed. In any method used to divide the mediastinum, the divisions are theoretical rather than physical. In other words, even though the divisions aren't physical, they should be visually comprehensible. Because there are no apparent physical boundaries between the compartments, disease can spread from one compartment to another, and some diseases do not occur exclusively in any one compartment. It is often more instructive to determine precisely where an abnormality lies within hundreds of sections.

As a result, for practicality and ease of classification, we have adopted the modified anatomic method of dividing the mediastinum into 3 compartments (the anterior, middle, and posterior compartments, with no separate superior compartment), and then divide each compartment into 3 subcompartments for a total of 9 compartments [Table/Fig-1]. In this way, the mediastinum has been separated into 3 main compartments and 9 sub compartments [Table/Fig-2]. Thus, while mediastinal computed tomography defines the location of any lesion, telling which of these 9 sub compartments are included, will make identification of the lesion site easier and more understandable.

For example, we will consider that a lesion, defined as compartment 9, may be at or distal to the distal oesophagus distal to the posterior mediastinum. Or we will realize that a lesion identified as compartment 1 may be a lesion of the thymus gland or other structures proximal to the anterior mediastinum.

CONCLUSION

The new mediastinal compartment scheme is planned to enable exact identification of mediastinal abnormalities at cross-sectional imaging by radiologists and other clinicians.

We believe that partitioning the mediastinum into 9 numbered compartments will provide more easily understood location and spread of anatomical structures and lesions. Our findings shows, that the newly proposed mediastinal compartment model using axial images appears to be user friendly, so everyone can work with it easily and apply it to practical clinical applications and differential diagnoses.

However, the boundaries between the compartments are not a complete anatomical boundary. Therefore, it should be accepted that there may be transitions between compartments when describing.

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