Anatomical variations of the azygos venous system

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INTRODUCTION

The azygos vein (gr. azygos – ‘unpaired’) typically starts from the posterior aspect of the inferior vena cava (IVC), at or below the level of the renal veins. The origin is not constant. If present, the lumbar azygos ascends anterior to the upper lumbar vertebrae. It may pass behind the right crus of the diaphragm or pierce it, or it may traverse the aortic hiatus to the right of the cisterna chyli. Anterior to the twelfth thoracic vertebral body, the azygos is joined by a large vessel formed by the right ascending lumbar and subcostal veins that passes forward and to the right of the twelfth thoracic vertebra behind the right crus. In the absence of a lumbar azygos this common trunk may form the azygos vein itself. Whatever its origin, the azygos vein ascends in the posterior mediastinum to the level of the fourth thoracic vertebra, where it arches forward above the right pulmonary hilum. It ends in the superior vena cava, before the latter pierces the pericardium.

The hemiazygos vein is formed on the left side from the lower three posterior intercostal veins, a common trunk formed by the left ascending lumbar and subcostal veins, and by esophageal and mediastinal tributaries. It ascends anterior of the vertebral column to the eighth thoracic level then crosses the vertebral column posterior to the aorta, esophagus and thoracic duct and ends in the azygos vein. Its lower end is often connected to the left renal vein [1].

The azygos system of veins drains most of the posterior abdominal and thoracic wall. It also receives mediastinal, bronchial and esophageal veins. The azygos vein serves as an important channel of communication between superior and inferior venae cavae. The vein also communicates with the vertebral venous plexus.

The azygos vein system functions as an additional drainage way when high pressure and obstruction occurs in most of the veins that inferior vena cava vein drains. In the obstruction of the IVC, it joins whole venous drainage below the diaphragm except the digestive system. This system connects to the cerebral vein system with the intercostal veins and vertebral venous plexuses. This connection is important because of venous metastatic pathways in breast and bronchial cancers. Also, in superior vena cava syndrome it joins with IVC [2-4]. Azygos veins are therefore important cava-caval and porto-caval junctions which form a collateral circulation in caval vein occlusion and in portal hypertension [5].
Variations related to the azygos system are not rare. They vary much in their mode of origin, course, tributaries, anastomoses and termination. Though the anatomical variations in the azygos system are physiologically normal, it is important to be aware of the unique yet normal variations of the azygos venous system during mediastinal surgeries to prevent inadvertent hemorrhagic complications [6]. These variations are also important from a radiological perspective and hence the aim of the present study is to document these variations and try to deduce an embryological explanation for them.

Materials and methods

The study was carried out in the Department of Anatomy, Konaseema institute of medical sciences and research foundation, Amalapuram. A total number of 40 cadavers, irrespective of age and sex were selected for this study spanning over a period of 2 years.

The pericardium, heart, lungs, thoracic aorta and esophagus were removed after the removal of the anterior thoracic wall. The azygos, hemiazygos, accessory hemiazygos and posterior intercostal veins were exposed by blunt dissection of the parietal pleura. Subsequently, the anterior abdominal wall was removed with its parietal peritoneum. The intestines and abdominal organs were removed, the diaphragm was elevated and the ascending lumbar veins were exposed. The azygos venous system was dissected and photographs were taken.

In the present study variations were observed in 9 cases and the remaining 31 cadavers the azygos venous system followed the normal anatomical pattern. The various anomalies as noted are mentioned as follows-

Variation 1: In 2 male cadavers (5%) a communicating vein is present between left brachio-cephalic vein and the azygos vein. the accessory hemi-azygos vein is absent and the hemi-azygos vein is present draining into the azygos vein (figure 1).

Variation 2: In 2 male (5%) cadavers there were 3 transverse channels connecting the accessory hemiazygos and hemiazygos with the azygos vein (figure 2).

Variation 3: In 1 male cadaver (2.5%) the left superior intercostal vein drains into the accessory hemiazygos vein instead of the left brachio-cephalic vein. The posterior intercostal veins of the 4th, 5th, 6th and 7th spaces join to form the accessory hemiazygos vein following the normal anatomical pattern which eventually drains into the azygos vein (figure 3).

Variation 4: In 4 female (10%) cadavers there was no communication between azygos system of veins. Azygos vein was present on both the sides (figure 4).
Variation 3: in this type of variation the left superior intercostal vein drains into the accessory hemiazygos vein. This vein is having no connection with the left brachio-cephalic vein. This may be due to regression of the cranial part of the left posterior cardinal vein and persistence of the communication between the caudal part of left posterior cardinal vein and the left azygos venous line.

Variation 4: Anson and McVay [11] described three types of azygos venous systems (with subgroups). Many interpersonal differences are evident because of variations in the division, adjunction and closure of 10 longitudinal and over 10 transverse veins that develop in the embryo. In this case, a Type 1 anomaly was evident. This primitive embryological form consists of two separate veins running in parallel in the posterior mediastinum anterior and lateral to the vertebral column. Such parallel veins are an azygos vein on the right and accessory and hemi-azygos veins, which form a single vein, on the left. The left-side veins, into which the left lumbar vein opens, subsequently open into the left brachio-cephalic vein [11].

**Discussion**

Knowledge of development of azygos system of veins is necessary to understand the variations of azygos, hemiazygos and accessory hemiazygos veins. Azygos venous system embryologically generates from sub cardinal veins. The right sub cardinal vein forms azygos vein and the left sub cardinal vein forms hemiazygos vein. The left superior intercostal vein and accessory hemiazygos vein are derived from the left posterior cardinal vein and this vein simultaneously forms the upper part of the azygos vein. The part that connects hemiazygos vein to azygos vein is actually remainder of the anastomoses between the left and the right posterior cardinal vein [7]. In the present study the observed anatomical variations are explained as follows.

**Variation 1:** in this case the communicating vein between the left brachiocephalic vein and the azygos vein is said to be the persistence of communication between cranial part of left post-cardinal vein and cranial part of left azygos venous line. The embryological event of non-regression of the terminal parts of the posterior cardinal veins, speculated to be the reason of the variation in this case, is further substantiated by the observation that the superior left intercostal vein ends in this long venous channel and this channel itself joins the left brachio-cephalic vein. A review of the case presented by Özdemir et al [8] also states that in absence of the hemiazygos vein, the left superior intercostal vein formed the terminal conduit for the entire upper left posterior thorax for its venous drainage. Mahato reported the variant accessory hemiazygos system with persistent cranial segment of posterior cardinal vein [9].

**Variation 2:** in this variation anumber of retro-aortic transverse anastomoses between the azygos system and the hemiazygos venous system are present. It is due to the persistence of the venous channels between the azygos lines on the two sides. In their study of the azygos venous system T. Kutoglu et al [10] observed 24 cases where multiple retro-aortic anastomoses were present which they called the transition type or type II.

**Variation 3:** in this type of variation the left superior intercostal vein drains into the accessory hemiazygos vein. This vein is having no connection with the left brachio-cephalic vein. This may be due to regression of the cranial part of the left posterior cardinal vein and persistence of the communication between the caudal part of left posterior cardinal vein and the left azygos venous line.

**Conclusion**

The variations mentioned above are not exclusive and the authors have avoided using any established classification to described them because all types of variations are not present and because of the limited number of cases. Nonetheless it is very important to document these variations in the azygos venous system because of its clinical significance.

It is very important to identify variations of the azygos system especially when CT of the mediastinum is performed. An abnormal azygos venous system may be easily confused with an aneurysm, lymphadenopathy or other abnormalities [12, 13].

Anomalies of the venous system are well-known. Venous anomalies are often detected only during surgery. The most troublesome intra-operative hazard is hemorrhage, which is mainly of venous origin [6]. To avoid such situations is to have an awareness and knowledge of the expected venous anomalies. A knowledge of such anomalies prior to operative procedures could be useful to surgeons operating on the posterior mediastinum.

**References**


