

## THE AZYGOS VENOUS SYSTEM AND ITS ANATOMICAL VARIATIONS

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### ABSTRACT

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#### AIMS AND OBJECTIVES

Azygos veins are important cavocaval and portacaval junctions, which form a collateral circulation in caval vein occlusion and in portal hypertension, cirrhosis of liver. The unpaired azygos venous system consists of azygos vein, hemiazygos vein and accessory azygos vein. This system of veins, along with its mediastinal, bronchial and oesophageal tributaries drains most of the body wall of trunk, namely posterior abdominal and thoracic wall. Anatomical variations of this unpaired azygos venous system are clinically important.

#### AIMS

To study and report the occurrence of anatomical variations of the unpaired azygos venous system in the region of East Godavari District, Andhra Pradesh (India).

#### METHODS

The present study was carried out in the Department of Anatomy, KIMS & RF, Amalapuram and G.S.L. Medical College, Rajahmundry over a period of 2 years. The present study was conducted on 60 cadavers (irrespective of age and sex). The entire course of the azygos venous system in these 60 cadavers was carefully observed and documented.

#### RESULTS

Anatomical variations were present in 16.66% of cases, out of which three distinct types were identified. 6.6% exhibited two separate azygos venous systems with no communications, 5% with communication between the left brachiocephalic vein and the azygos vein and 5% presence of post-aortic venous channels.

#### CONCLUSION

Variations of azygos venous system may be wrongly dubbed as aneurysm, lymphadenopathy or other abnormalities while reporting a CT scan of mediastinum. Venous anomalies are also detected only during surgery. The most troublesome intraoperative hazard is haemorrhage, which is mainly of venous origin. To avoid such situations is to have an awareness and knowledge of the expected venous anomalies.

#### KEYWORDS

Azygos vein, Accessory Azygos Vein, Hemiazygos Vein, Anatomical Variations, Mediastinal Surgeries, Posterior Mediastinum.

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**INTRODUCTION:** Azygos veins are important cavocaval and portacaval junctions which form a collateral circulation in caval vein occlusion and in portal hypertension, cirrhosis of liver.<sup>(1)</sup> The unpaired azygos venous system consists of azygos vein, hemiazygos vein and accessory azygos vein. This system of veins, along with its mediastinal, bronchial and oesophageal tributaries drain most of the body wall of trunk, namely posterior, abdominal and thoracic wall.<sup>(2)</sup> The azygos vein starts from the posterior aspect of the inferior vena cava (IVC) at the level of the renal veins.

Sometimes, it begins as the lumbar azygos vein, ascends anterior to the upper lumbar vertebrae.

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It may pass behind the right crus of the diaphragm or pierce it, or it may pass through the aortic hiatus along with thoracic duct and aorta. In the absence of lumbar azygos vein, the azygos vein is formed by the right ascending lumbar and subcostal veins at the level of twelfth thoracic vertebrae that passes behind the right crus of diaphragm. The azygos vein ascends in the posterior mediastinum up to the fourth thoracic vertebrae, where it arches over the root of right lung and terminates in the superior vena cava, before it pierces the pericardium. Thus, the azygos vein is a communicating channel between superior and inferior vena cava and also communicates with the vertebral venous plexus.

The hemiazygos vein passes upwards in front of the vertebral column up to the level of eighth thoracic vertebrae where it crosses the vertebral column posterior to the aorta, oesophagus and thoracic duct and ends in the azygos vein. The hemiazygos vein is formed by the left ascending lumbar and subcostal veins on the left side.

The tributaries of hemiazygos vein are the lower three posterior intercostal veins, oesophageal and mediastinal veins. The azygos vein system functions as an alternative way of drainage in case of obstruction of inferior vena cava and its tributaries. In the obstruction of the IVC, it joins whole venous drainage below the diaphragm except the digestive system. This azygos venous system communicates with cerebral vein system via the intercostal veins and vertebral venous plexuses. This connection serves as a route for the spread of cancers of breast and lung to the brain.<sup>(3)</sup>

The anatomical variations of the azygos system are not uncommon. They vary in their mode of origin, course, tributaries, anastomoses and termination. Though the anatomical variations in the azygos system are physiologically normal, but it is important to be aware of normal variations of the azygos venous system during mediastinal surgeries to prevent inadvertent haemorrhagic complications.<sup>(4)</sup> 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) and G.S.L. Medical College (Rajahmundry). A total number of 60 cadavers, irrespective of age and sex were selected for this study over a period of 2 years. The pericardium, heart, lungs, thoracic aorta and oesophagus 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.

**RESULTS:** In the present study, variations were observed in 10 cases (16.66%) and the remaining 50 cadavers, the azygos venous system followed the normal anatomical pattern. The various anomalies as noted are mentioned as follows:

**Variation 1:** In 4 (6.6%) cadavers, there was no communication between azygos system of veins. Azygos vein was present on both the sides (Figure 1).



**Fig. 1: Two Separate Azygos Venous System with No Communications**

**Variation 2:** In 3 cadavers (5%), a communicating vein is present between left brachiocephalic vein and the azygos vein. The accessory hemiazygos vein is absent and the hemiazygos vein is present draining into the azygos vein (Figure 2).



**Fig. 2: Communication between the Left Brachiocephalic Vein and the Azygos Vein**

**Variation 3:** In 3 (5%) cadavers, there were 3 transverse channels connecting the accessory hemiazygos and hemiazygos with the azygos vein (Figure 3).



**Fig. 3: Accessory Hemi-Azygos and the Azygos Vein Joined by Post Aortic Venous Channels**

**DISCUSSION:** Subcardinal veins are the embryological origin for azygos venous system; variations of this system of veins are comprehensible only with a proper knowledge of its development. Azygos vein is formed from the right subcardinal vein and the left subcardinal 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.<sup>(5)</sup> In the present study, the observed anatomical variations are explained as follows:

**Variation 1:** In the first type of variation present, both sides exhibit presence of separate azygos veins with no communication between them. During the early stages of embryonic development, at least 10 longitudinal and transverse veins develop which is followed by various modes of division, adjunction and closure.

The 3<sup>rd</sup> variation may be a result of such differential fate of the developing azygos venous channels. This type can be classified as a type I anomaly as described by Anson and McVay.<sup>(6)</sup> Srinivas Rao Y et al<sup>(7)</sup> described a similar primitive embryological form consisting of two separate parallel veins running in the posterior mediastinum anterior and lateral to the vertebral column. Such parallel veins are an azygos vein on the right and accessory and hemiazygos 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 brachiocephalic vein.<sup>[6]</sup>

**Variation 2:** This variation comprises of the following:

1. There is a communicating vein between left brachiocephalic vein and azygos vein.
2. Superior left intercostal vein ends into this communication.
3. Accessory hemiazygos vein is absent.

Embryologically, this variation can be explained by non-regression of the terminal parts of the posterior cardinal veins. Similar variation was reported by Srinivasa Rao Y et al.<sup>(7)</sup> The role of left superior intercostal vein in serving as the terminal conduit for the upper left posterior thorax has also been emphasised in yet another report presented by Özdemir et al<sup>(8)</sup> Similarly persistence of cranial segment of posterior cardinal vein was also reported by Mahato et al.<sup>(9)</sup>

**Variation 3:** In the third type of variation noted, there were numerous retroaortic transverse anastomoses between the azygos system and the hemiazygos venous system; this is classified as transition type anomaly or type II anomaly.<sup>(10)</sup> Embryologically, it can be explained by persistence of the venous channels between the azygos lines on the two sides. Similar reports have been published by Kuoglu et al<sup>(10)</sup> & Srinivas Rao Y et al<sup>(7)</sup>

**CONCLUSION:** Variations of azygos venous system may be wrongly dubbed as aneurysm, lymphadenopathy or other abnormalities while reporting a CT scan of mediastinum.<sup>(11,12)</sup> Venous anomalies are also detected only during surgery. The most troublesome intraoperative hazard is haemorrhage, which is mainly of venous origin.<sup>(13)</sup> To avoid such situations is to have an awareness and knowledge of the expected venous anomalies. The present study did not document all types of variations; hence, this study is neither exclusive nor conclusive regarding the entire spectrum of variations present in azygos system of veins.

In spite of these limitations, the importance of the present study cannot be undermined considering its profound clinical significance.

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