Study of Various Patterns of Azygos Venous System and its Clinical Significance

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Abstract

Background: The azygos system includes those veins which are straight in course, paravertebral in position and not accompanied with the corresponding arteries. The azygos vein may arise as lumbar azygos vein from the back of inferior vena cava or by the union of right subcostal and right ascending lumbar veins. It enters the thorax, receives lower 8 right posterior intercostal veins, superior intercostal vein, hemiazygos and accessory hemiazygos veins and ends by joining the superior vena cava. The hemiazygos vein is formed on the left in a manner similar to that of azygos vein. The aim of the present study was to investigate the various patterns of the azygos venous system.

Methods: A total number of 30 cadavers were studied and were evaluated based on the study of Anson BJ and Mcvay CB.

Conclusion: Out of 30 specimens studied, 17 (56%) specimens showed normal pattern, 5 (16%) specimens showed caterpillar pattern and rest 8 (26%) specimens showed ladder pattern.

Azygos system of veins serve as an alternative drainage channel between superior vena cava and inferior vena cava in case of obstruction. The knowledge of various patterns could be useful for radiologists and surgeons to prevent intra-operative hazards.

Key Words: *Azygos venous system, Caterpillar, Hemiazygos vein, Ladder.*

Introduction

The azygos system includes those veins which are straight in course, paravertebral in position and not accompanied with the corresponding arteries. This system communicates with the vena caval system in front and with the vertebral venous plexus behind and can provide an alternative pathway for blood to the right atrium when either of the venae cavae is blocked. The terminal veins of this system are the azygos, the hemiazygos and the accessory hemiazygos veins.

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The azygos vein is unpaired and mostly lies on the right side of the thoracic vertebral column draining itself into the superior vena cava. While the hemiazygos vein and the accessory hemiazygos vein present on the left side of the body, they are considered tributaries of azygos vein rather than its left side equivalent[1], hence the vein is so named.

Variations can be found by various researchers in origin and branches of different arteries like external carotid artery[2] and brachial artery[3], unilateral or bilateral absence of nerves[4] and also in venous system[5]. The azygos system of veins is also subjected to wide range of variations in relation to origin, course, pattern, tributaries and anastomoses[6].

Anomalies of azygos veins are not very rare. Several deviations in pattern of this venous system are reported in the literature[7-11] and these variations result predominately due to its complex embryological development. The development of this system is controversial but the azygos vein is considered to derive from the upper right supracardinal vein, the azygos arch from an upper segment of the right posterior cardinal vein and the hemiazygos and accessory hemiazygos veins from the left supracardinal vein and the terminal part of the left posterior cardinal vein.

The persistence of the embryological subcentral anastomosis between the right and left supracardinal veins form the transverse anastomosis between azygos and hemiazygos vein that gives the appearance of a ladder.

The various patterns of this system do exist and are physically normal. So, knowledge of these patterns is important during magnetic resonance imaging reports and mediastinal computed tomography and also important for cardiothoracic surgeons to prevent inadvertent haemorrhagic complications during mediastinal surgeries[8].

Method and Materials

The present study was carried out on a total number of 30 cadavers irrespective of age and sex were selected for this study. The pericardium, heart, lungs and oesophagus were removed after the removal of anterior thoracic wall. The azygos, hemiazygos and accessory hemiazygos veins were exposed to look for the formation, course and termination and the photographs were taken. The cases were evaluated based on the study of Anson BJ and McVay CB[7]. Three main types of azygos venous system (primitive or embryological type, transition type and single column type) were evaluated. The patterns are also defined based on the vertical forms and horizontal connections.

Results

In the present study, out of 30 specimens studied, 17 (56%) specimens showed normal pattern of azygos venous system, while the 5 (16%) specimens showed the (caterpillar pattern) single azygos vein towards midline and rest 8 (26%) specimens showed ladder pattern (as shown in Table 1). A ladder is a vertical or inclined set of rungs or steps.

Various patterns are as follows:

Type 1. Normal pattern of azygos venous system (Atypical).

Type 2. Caterpillar Pattern (Single Azygos Vein): Shifting of azygos vein towards midline along with absence of hemiazygos vein and accessory hemiazygos vein. The right and left posterior intercostal veins directly drain into the azygos vein and the pattern resembles to a caterpillar (Fig.1a, 1b, 1c).

Type 3. Ladder Pattern: There is transverse connection between the hemiazygos and accessory hemiazygos veins with the azygos vein across the vertebral column like a ladder (Fig.2a, 2b, 2c).

Table 1. Showing the various pattern of azygos venous system.

Pattern of azygos venous system	No. of specimens	Percentage
Normal (atypical)	17	56%
Caterpillar (single azygos vein)	5	16%
Ladder (transverse connection)	8	26%

Discussion

According to Anson's system of classification:

Type-I: This primitive and embryological form consists of two separate veins lying in parallel to each other in the posterior mediastinum, being anterior and lateral to the vertebral column with no connections between them. It is seen in 1% cases.

Type-II: 98% of all cases are in this form and it is known as the transition type. There are multiple retro-aortic anastomoses between the azygos and hemiazygos venous systems.

Type-III: It consists of a single azygos vein lying at the midline, on the anterior surface of the vertebral column.

In the present study, 5 of our cases (caterpillar pattern) show shifting of azygos vein towards midline with the absence of hemiazygos vein and accessory hemiazygos vein comes under Anson's type-III.

The other 8 cases (ladder pattern) show horizontal or retroaortic anastomosis between the hemiazygos and accessory hemiazygos veins with the azygos vein. This is according to type-II Anson's classification. It is due to the persistence of venous channels between the azygos lines of two sides.

Bergmann et al have reported variations of azygos vein. The azygos vein receives the hemiazygos vein at T_8 or T_9 and accessory hemiazygos vein at T_6 or T_7 vertebra. When hemiazygos and the accessory hemiazygos veins are not completely formed, the posterior intercostal veins on the left side of thorax may drain into azygos vein independently and it lies in the midline[8].

Dharan N & Soames R reported a single vein which is formed by union of azygos and hemiazygos veins which is located in midline draining the right and left posterior intercostal veins into the superior vena cava and 26 cases of retroaortic communication in their study[10].

T. Kutoglu et al in his study observed 1 case of single azygos vein and 44 cases of multiple retroaortic anastomosis[11].

Shivanal U et al found shifting of azygos vein towards midline along with absence of accessory hemiazygos vein and similar type of transverse connections between azygos and hemiazygos venous system[12].

Satheesha Nayak et al observed the midline position of azygos vein which was possibly due to the old age and also reported 6 horizontal channels across the vertebral column connecting the azygos vein with the accessory hemiazygos and hemiazygos veins[13].

Saito A et al also reported the shifting of azygos vein towards the midline or left side due to aging[14].

Rao Y S & Banerjee A found the similar observation of three transverse retroaortic anastomosis between azygos and hemiazygos veins[15].

Kumar et al in his case report found a ladder pattern of azygos venous system[16].

Table 2. The following studies have classified the azygos venous system into three main types. Each of which has different sub-grouping.

Research Study	Parallel Pattern (Type I)	Ladder Pattern (Type II)	Caterpillar Pattern (Type III)
Anson and McVay[7]	1	98	1
Bergmann et al[8]	-	-	1
Dahran & Soames[10]	1	26	3
Kutoglu et al[11]	1	44	1

Cont... **Table 2. The following studies have classified the azygos venous system into three main types. Each of which has different sub-grouping.**

Shivanal & Geethanjali[12]	-	1	1
Satheesha et al[13]	-	6	1
Saito et al[14]	-	-	1
Rao & Banerjee[15]	4	2	-
Kumar et al[16]	-	1	-
Present Study	--	8	5

Knowledge of these different variations is important in CT and MRI scans because some variations of azygos venous system can be confused with aneurysm, lymphadenopathy and tumours of posterior mediastinum.

Fig.1: Showing Azygos Venous System Caterpillar Pattern (1a, 1b, 1c)

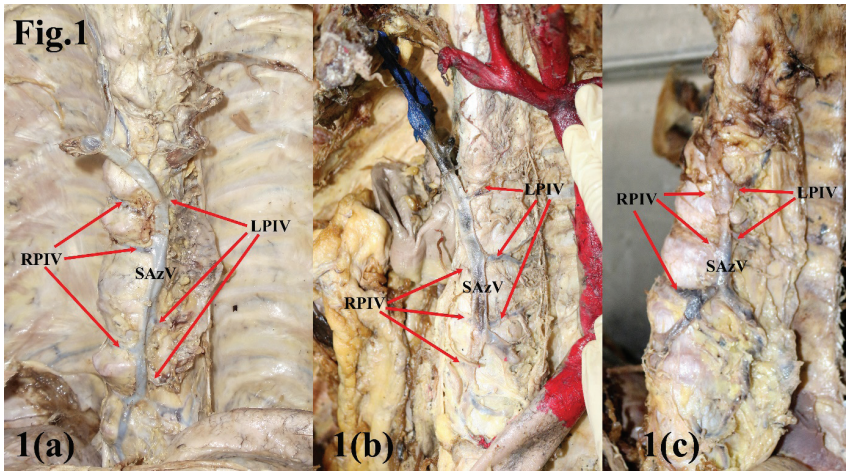

Fig.(1a,1b,1c)- Presenting the caterpillar pattern of azygos venous system with reverse curving of azygos vein in fig.1(a); SAz- single azygos vein; RPIV- right posterior intercostal vein; LPIV- left posterior intercostal vein.

Fig.2: Showing Azygos Venous System Ladder Pattern (2a, 2b, 2c)

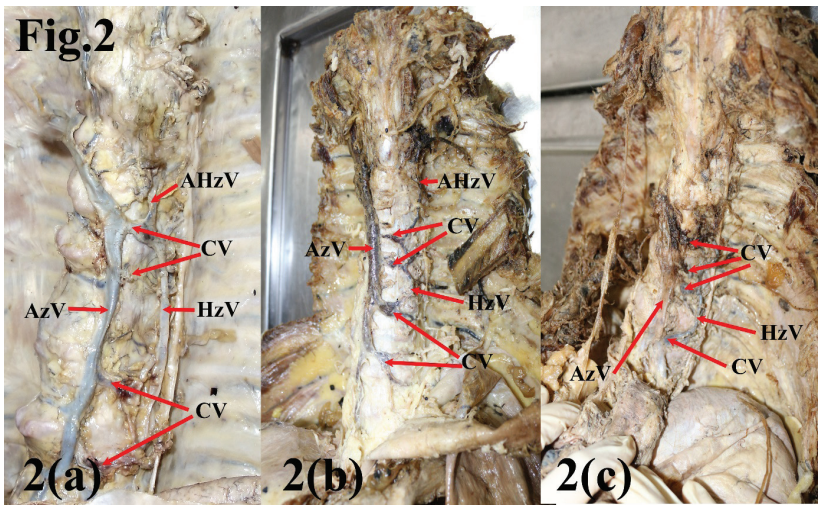

Fig.(2a,2b,2c)- Showing azygos venous system ladder pattern; Az- azygos vein; AHz- accessory hemiazygos vein; Hz- hemiazygos vein; CC- cross communication

Conclusion

Azygos system of veins serve as an alternative drainage channel between inferior vena cava and superior vena cava in case of obstruction. Anomalies of this system are often detected only during surgery which cause intra-operative hazards mainly haemorrhage. This knowledge of various patterns could be useful for surgeons to prevent such hazards.

Ethical Clearance- Taken from Biomedical Research Ethics Committee, Pt. B. D. Sharma Post Graduate Institute of Medical Sciences, UHS, Rohtak.

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