

## VARIATIONS OF ARCH OF AZYGOS VEIN: AN ANATOMICAL OVERVIEW WITH CLINICAL IMPORTANCE

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### ABSTRACT

**Background:** The azygos venous system represents an accessory venous pathway supplying an important collateral circulation between the superior and inferior vena cava. The azygos vein is a collateral venous pathway, becoming a vital shunt if major pathways of venous return are obstructed.

**Material and Methods:** A total of 36 cadavers and dissected specimens were studied. A thorough dissection of the mediastinum was done after the removal of heart and the lungs. The shape, level of termination, dimensions and course & relations of arch of azygos vein was noted on the right side. The diameter of the inferior vena cava was also measured.

**Observations and Results:** most commonly the arch forms an inverted U shaped course. 89% of the case the azygos vein was opening into extra-pericardial part of superior vena cava at a mean distance of 42.5mm from the formation. In 19 (53%) cases out of 36 it was opening into superior vena cava at the level of T4. Next commonest level of opening (14%) was at the junction of T3-T4. length varied from 28 to 48 mm. The mean width of IVC was 18 mm +/- 3.5mm. It was observed that the diameter of IVC is inversely proportional to width of azygos vein.

**Conclusion:** In the present study the normal variations of the morphometry of azygos vein is noted. It is clear that the diameter of SVC is inversely proportional to that of Azygos vein.

**KEY WORDS:** Arch, Azygos vein, Inferior Vena Cava, Superior Vena Cava.

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### INTRODUCTION

The azygos venous system represents an accessory venous pathway supplying an important collateral circulation between the superior and inferior vena cava. The azygos vein is a collateral venous pathway, becoming a vital shunt if major pathways of venous return are obstructed. At T5–T6, it arches ventrally just cephalad to the right main bronchus and drains into the SVC

or, rarely, into the right brachiocephalic vein, right subclavian vein, intrapericardial SVC, or right atrium [1]. It may open directly into the right atrium (ascribed to the embryonic disappearance of the right common cardinal vein). The azygos occasionally opens into the right brachiocephalic or even the right subclavian (believed to be caused by an elongated embryonic right common cardinal vein) [2].

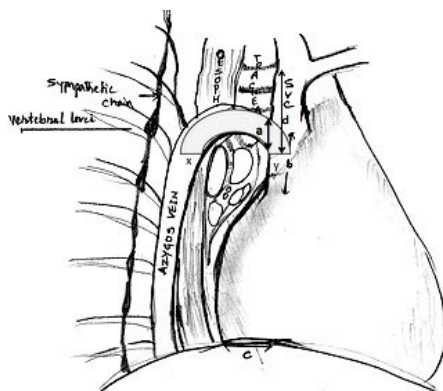
Azygos vein enlargement can be detected in congestive heart failure, portal hypertension, inferior vena cava thrombosis, right atrial mural thrombosis, a pulmonary embolism, congenital azygos continuation to the inferior vena cava, and the arteriovenous fistula. Radiography, particularly computed tomography (CT), is very useful, not only in recognition of azygos vein enlargement, but also in evaluation of its etiology for the institution of the appropriate treatment of the diseases [3]. The course of the azygos vein within the mediastinum determines the anatomic arrangement of the posterior right mediastinal pleura. Lung intruding into the mediastinal recesses above and below the azygos arch provides contrast which allows demonstration of detailed normal mediastinal anatomy [4].

Many authors have studied the azygos system and its variations in formation, tributaries and terminations. In this study, the variations of terminal part of azygos vein (arch of azygos vein) are studied with the relations of other structure in the vicinity.

## MATERIALS AND METHODS

The study was carried out in the Dept. of Anatomy, S.S.Institute of Medical Science and Research Centre, Davangere. A total of 36 cadavers and dissected specimens were selected irrespective of the age and gender. A thorough dissection of the mediastinum was done after the removal of heart and the lungs. The shape, level of termination, dimensions and course & relations of arch of azygos vein was noted on the right side. The diameter of the inferior vena cava was also measured.

**Fig.1:** Schematic diagram of morphometric measurements.



a : width of azygos vein, b : distance from root of SVC, c : diameter of IVC, d : length of arch of azygos vein, vl : vertebral level.

**Fig. 2:** Inverted "U" shaped arch terminating at T4.



**Fig. 3:** Inverted "L" shaped arch terminating at T3.



**Fig. 4:** Inverted "U" shaped arch terminating at T3.





**Fig. 5:** Short length of AV due to median course.



**Fig. 6:** Arc shaped arch terminating at T3.



**Fig. 7:** Arc shaped arch terminating at the junction of formation of SVC on left side.

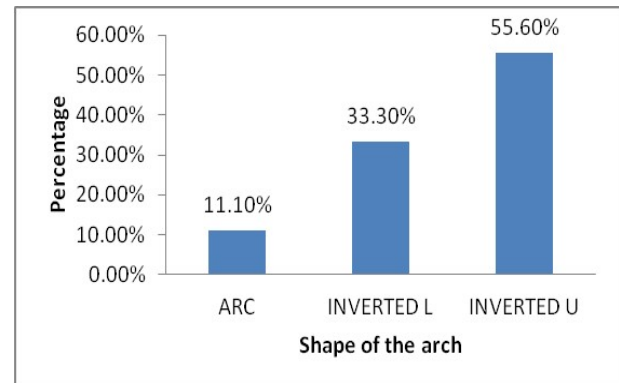


## OBSERVATIONS AND RESULTS

**Shape of the arch of Azygos vein:** It was observed that most commonly the arch forms an

inverted U shaped course (graph.1). This is seen in 20 cases. Out of 20 cases 12 were opening at the level of T4, 2 at the level of T3-T4, 2 at the level of T4-T5 and 4 at the level of T5.

**Graph 1:** variations in the shape of arc of AV.



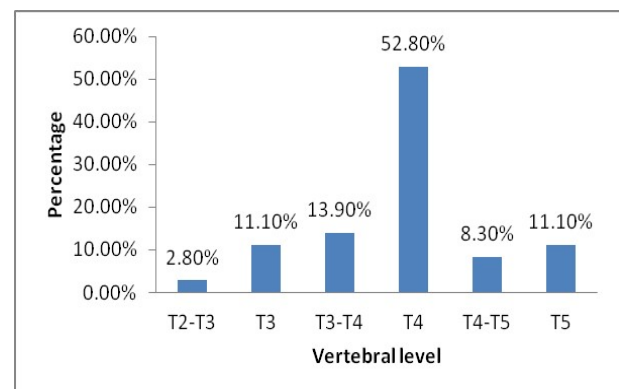
**Site of opening:** in 89% of the case the azygos vein was opening into extra-pericardial part of superior vena cava at a mean distance of 42.5mm from the formation. In 3 cases it was found to be opening into right brachio-cephalic vein and in a rare case it was opening into left brachio-cephalic vein at the angle of formation of superior vena cava (Table.1).

**Table 1:** Variations of site of termination of AV.

Site of opening	No. of Patients	Percent
LBCV	1	2.8
RBCV	3	8.3
SVC	32	88.9
Total	36	100

**Level of opening:** In 19 (53%) cases out of 36 it was opening into superior vana cava at the level of T4. Next commonest level of opening (14%) was at the junction of T3-T4. Very rarely it opens above the level of T3. (graph.2).

**Graph 2:** Varying vertebral levels of termination of AV.



**Morphometry of Azygos vein (Table.2):** The length of the arch of AV varied from 28 to 48 mm. The varying length is mainly due to the level

opening and width of the hilum of right lung. The mean length being 40  $\pm$  6mm. The mean width of azygos vein at the opening was 8mm  $\pm$  2.7mm.

Diameter of IVC and its correlation with width of azygos vein (Table.3). The mean width of IVC was 18 mm  $\pm$  3.5mm. It was observed that the diameter of IVC is inversely proportional to width of azygos vein (graph.3).

**Table 2:** Morphometry of arch of AV.

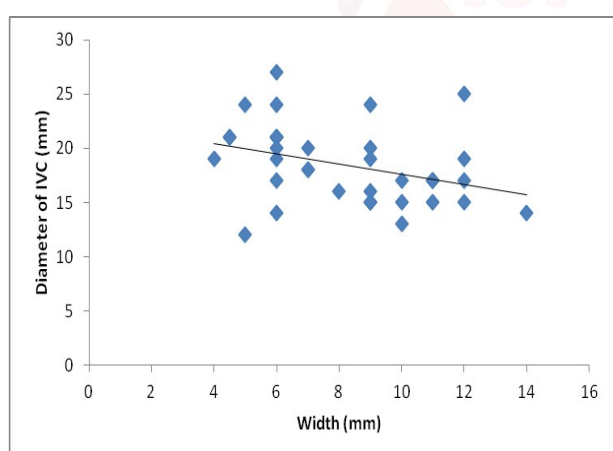
	N	Minimum	Maximum	Mean	Std. Deviation
Length (MM)	36	28	48	39.78	5.95
Width (MM)	36	4	14	8.19	2.71
Diameter of IVC (MM)	36	12	27	18.42	3.56

**Table 3:** Correlation between the width of AV and diameter of IVC.

	Diameter of IVC (MM)	Width (MM)
Diameter of IVC (MM)	1	-0.354*
Width (MM)		1

\*. Correlation is significant at the 0.05 level (2-tailed).

**Graph 3:** Scatter Diagram depicting correlation between the width of AV and diameter of IVC.



## DISCUSSION

The formation, course, tributaries and the variations of azygos vein has been studied by various renowned researchers. But a very few authors have mentioned the course, morphometry and variations in the termination of azygos vein, that is arch of azygos vein. This is of high clinical importance as it is situated in superior or anterior mediastinum in relation with hilum of right lung, trachea, phrenic nerve, sympathetic chain and formation of superior vena cava. Azygos system acts as major collateral pathway in case of venacaval obstructions. The presence of collateral vessels (regardless of their number

and location as shown by CT) is a highly sensitive and specific predictor of SVC syndrome in patients with CT evidence of SVC obstruction [5]. The azygos vein becomes significantly enlarged due to inferior vena cava interruption. Recognition of dilated azygos vein, secondary to superior vena cava thrombosis should always be taken into consideration in those patients with central venous catheters and neoplasm [6].

It has the ability to drain the lower half of the body into the SVC when the IVC is obstructed [5]. The shape of the azygos vein varied from complete arch to arc and even simple inverted "L" forms. Most commonly found shape was the arch (Graph.1). This can be accounted mainly for its length, course and level of opening. Most of the cases with the level of opening below T4 were forming a complete arch. In 89% of the case the azygos vein was opening into extra-pericardial part of superior vena cava at a mean distance of 42.5mm from the formation. In 3 cases it was found to be opening into right brachio-cephalic vein and in a rare case it was opening into left brachio-cephalic vein at the angle of formation of superior vena cava.

In the present study it was observed that 19 (53%) cases out of 36 azygos vein was opening into superior vena cava at the level of T4. Next commonest level of opening (14%) was at the junction of T3-T4. Very rarely it opens above the level of T3 (Graph.2). According to study conducted by Dahran, N. & Soames, R et al, 48% of the cases the Azygos vein was opening at the level of T3, 20% at the level of T2-T3 and 33% at the level of T2 [7]. A similar study by Kanchana latha G., Raju Sugavasi states that, out of 82 adult cadavers 7 were terminated at third and 75 were at fourth thoracic vertebra. Out of 10 fetuses one at third, two at fourth, and seven at the level of fifth thoracic vertebra. In all the 8 cadavers of children azygos vein terminated at the level of fourth thoracic vertebra [8].

The arching and opening level of the AV was at the fifth thoracic vertebra in most cases. The opening level was most often at the same level as the carina [9].

The study by T. Kutoglu, M. Turut et al., revealed that the levels of opening of azygos vein as, at T2-3 was 13.3%, at T2 was 26.7%, at T3-4 was 33.3% and at T3 was 66.7 % [10].

The Azygos vein arch appears like a tear-shaped shadow located at the caudal point of the right paratracheal stripe, just at the right tracheobronchial angle. It may be prominent when the Azygos vein is enlarged. Nevertheless, pathologies like pulmonary masses or mediastinal adenopathies sometimes create images so similar that it may be difficult to distinguish [11].

In the present study, the mean length being 40 +/- 6mm and the mean width of azygos vein at the opening was 8mm +/- 2.7mm. It was also observed that the mean width of IVC was 18 mm +/- 3.5mm and the diameter of IVC is inversely proportional to width of azygos vein (Table 2 and 3). Dahran, N. & Soames, R observed that, the mean diameter of the AV at its origin and termination was  $2.14 \pm 0.39$  mm and  $6.21 \pm 1.36$  mm, respectively, with the diameter at the termination almost three times larger than its origin [7]. According the study by M R Prince, R A Novelline et al., overall mean diameter was 20 mm, the range was 13 to 30 mm, and the standard deviation was 3 mm [12]. Tatar I, Denk CC in their study observed that, the diameter of the AV at the opening into the superior vena cava ranged between 4.3mm and 16 mm [9].

The study conducted by Dahran, N. & Soames, R. confirmed that the more communications between the right and left sides of the azygos system, then the larger the diameter of the AV at its termination [7]. The mean diameter of the azygos vein at its termination was  $8.56 \pm 1.26$  mm [10].

An increased pressure in right cardiac cavities can be transmitted to the superior vena cava and Azygos system with subsequent enlargement of these vessels. Probably it is the most common cause of a prominent Azygos arch found on chest radiographs. The azygos vein is more commonly anterior to the vertebral column and often passes to the left of the midline for part of its course. When there is congenital interruption of the IVC, the azygos vein can become as large as the IVC that it has replaced. Pathologies that develop an increased pressure in the vena cava system, such as obstructions, usually make the Azygos vein to be enlarged. This happens because venous flow in the Azygos system goes up. Cancer is being involved in the majority of patients with vena cava

obstruction, either by direct invasion, thrombosis or extrinsic compression of the vein [11]. Aneurism of AV (AVA) is a rare condition, however, when it does occur, making an accurate diagnosis can be difficult because this condition may mimic the appearance of a calcified mediastinal lymph node. AVA often enlarges, thus posing the risk of rupture [14]. The Azygos vein can be hurt by diagnostic or therapeutic procedures. These infrequent situations are usually related to interventions near the Azygos vein such as central venous catheter implant [11].

## CONCLUSION

A thorough knowledge of the morphometric variations and the relations of azygos vein is essential in the clinical fields especially surgery and radiology to distinguish various pathologies involved in structures of superior and posterior mediastinum and also during any surgical interventions and radiological investigations so as to avoid iatrogenic complications.. The results of this study can be useful in surgeries of mediastinum, vertebral column and hilar regions of lungs.

**Conflicts of Interests: None**

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