

# Variability of the azygos vein system in human fetuses

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*The aim of the study was to examine the variability of the azygos vein system and to determine the location of the veins with reference to the vertebral midline and the skeletopy of their termination. The research material consisted of 32 human fetuses (14 male, 18 female) from 21<sup>st</sup> to 24<sup>th</sup> week of intrauterine life, fixed in 10% neutral formalin solution. Conventional anatomical — radiographic methods were used. 5 different configurations of the azygos vein system were found. In the 1<sup>st</sup> configuration there were 3 azygos veins, with both the left side veins, the hemiazygos vein (HV) and the hemiazygos accessory vein (HAV), joining the azygos vein (AV) separately. In the 2<sup>nd</sup> configuration the HV and the HAV were joined to the AV together. In the 3<sup>rd</sup> configuration the HAV was missing, and the 4<sup>th</sup> to 8<sup>th</sup> left intercostal veins were joined to the AV separately. In the 4<sup>th</sup> configuration the HV was missing. In the 5<sup>th</sup> configuration there was the AV only, which coursed along the vertebral midline. In these 4 configurations (1–4) the AV was located on the right side (90.6%) and in the 5<sup>th</sup> configuration the AV was located in the vertebral midline. The termination of the AV projected mostly on Th<sub>4</sub> (81.25%). The junction of the HV and the AV was found the most frequently at Th<sub>8</sub> (35.7%), and the junction of the HAV and AV most frequently at Th<sub>7</sub> (41.6%).*

**key words:** azygos vein, hemiazygos vein, hemiazygos accessory vein, human configuration, fetuses

## INTRODUCTION

The azygos vein system develops on the basis of multiple transformation of the subcardinal veins, which causes its great variability, especially on the left side [4, 6]. Azygos veins are important cavo-caval and porto-caval junctions, thus forming collateral circulation in caval vein occlusion and in portal hypertension [1].

The aim of the study was to examine the variability of the azygos vein system and to determine the location of the veins with reference to the vertebral midline and skeletopy of their termination.

## MATERIAL AND METHODS

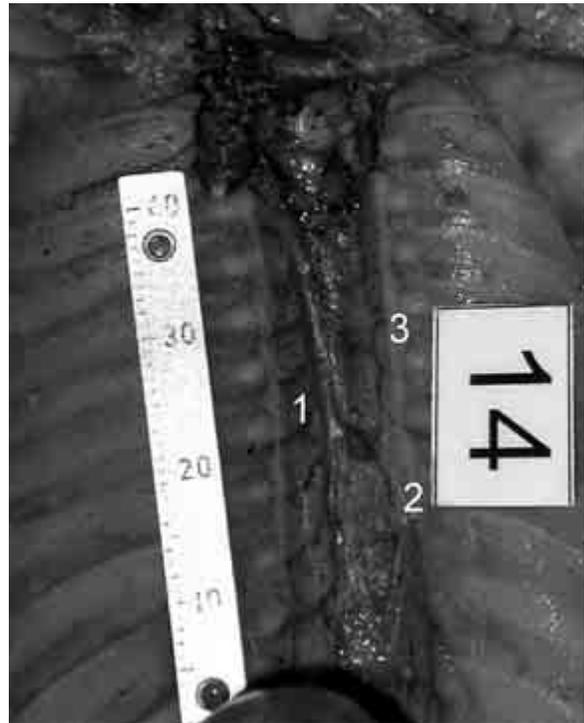
The research material consisted of 32 human fetuses from the collection of the Department of Normal Anatomy. The fetuses, 14 male and 18 female and from 21<sup>st</sup> to 24<sup>th</sup> week of intrauterine life, were fixed in 10% neutral formalin solution. In this research conventional anatomical — radiographic methods were used. After cutting the sternum in midline and pulling the ribs aside, the chest organs were removed and the azygos vein system prepared. Photographic documentation in situ was performed with a Nikon Coolpix Digital Camera. After marking

the termination of the 3 veins, P-A radiograms of this vascular area were made with Unipan 401 apparatus.

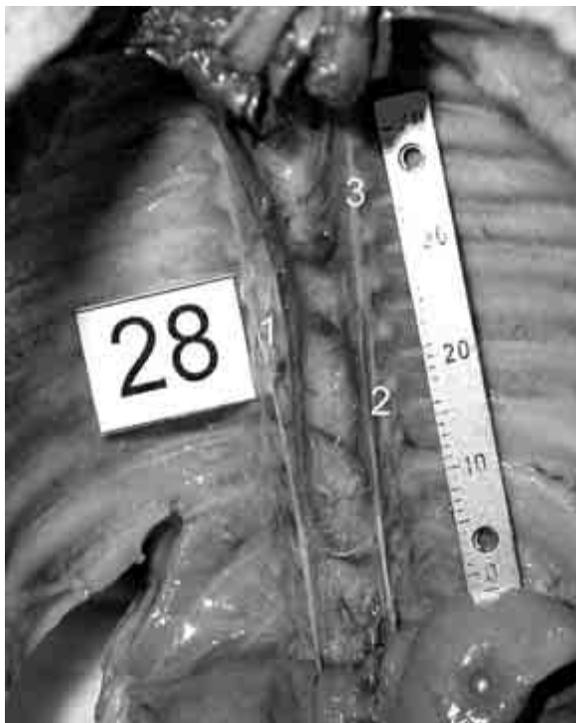
## RESULTS

### Configurations

5 different configurations of the azygos vein system were found in the material studied. In the 1<sup>st</sup> configuration (65.6%) there were 3 veins, both of those on the left, the hemiazygos vein (HV) and the hemiazygos accessory vein (HAV), joining the azygos vein (AV) separately (Fig. 1). The remaining 4 configuration views were observed with a different frequency. In the 2<sup>nd</sup> configuration (6.25%) the HV and the HAV were joined to the AV together (Fig. 2). In the 3<sup>rd</sup> configuration (12.5%) the HAV was missing (Fig. 3), and 4<sup>th</sup> to 8<sup>th</sup> left intercostals veins were joined to the AV separately. In the 4<sup>th</sup> configuration (6.25%) the HV was missing (Fig. 4). In the 5<sup>th</sup> configuration (9.4%) there was only the AV, which coursed along the vertebral midline (Fig. 5), and the posterior intercostals veins from both sides were attached to the AV.



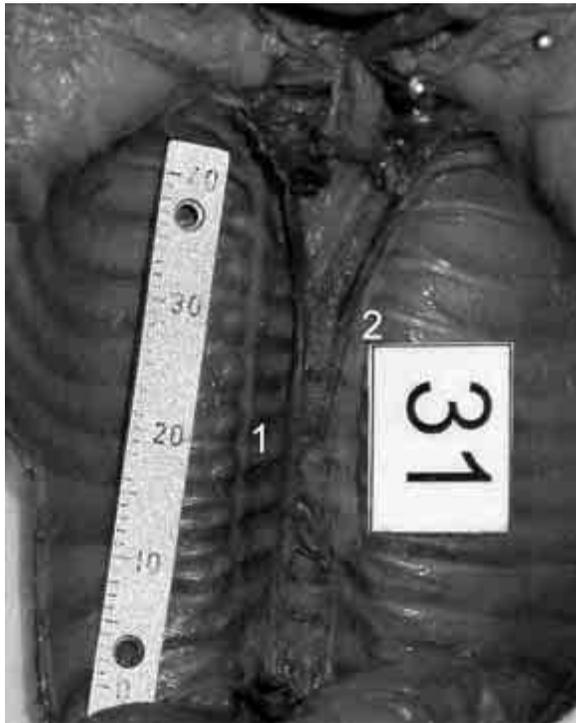
**Figure 2.** 2<sup>nd</sup> configuration of the azygos vein system; 1 — AV, 2 — HV, 3 — HAV.



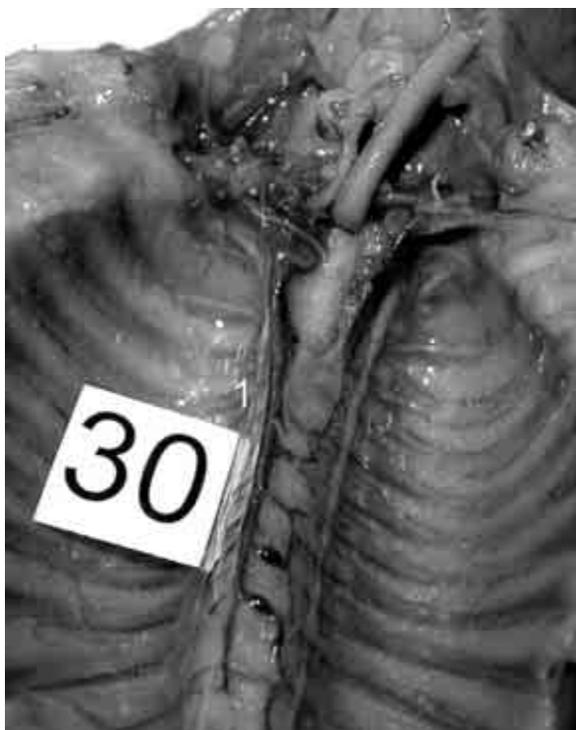
**Figure 1.** 1<sup>st</sup> configuration of the azygos vein system; 1 — AV, 2 — HV, 3 — HAV.



**Figure 3.** 3<sup>rd</sup> configuration of the azygos vein system; 1 — AV, 2 — HV.



**Figure 4.** 4<sup>th</sup> configuration of the azygos vein system; 1 — AV, 2 — HAV.



**Figure 5.** 5<sup>th</sup> configuration of the azygos vein system; 1 — AV.

Analysis of the azygos vein configurations indicates that the AV was found in all cases, the HV in 84.4%, and the HAV in 80% of cases. An azygos vein system consisting of 3 veins (1<sup>st</sup> and 2<sup>nd</sup> configurations) was observed in 71.85% of cases, of 2 veins (3<sup>rd</sup> and 4<sup>th</sup> configurations) in 18.75% of cases, and of 1 vein (5<sup>th</sup> configuration) in 9.4% of cases.

#### Skeletopic analysis

In 4 configurations (1<sup>st</sup>–4<sup>th</sup>) the AV was located on the right side (90.6%). In the 5<sup>th</sup> configuration the AV was located in the vertebral midline. The junction of the AV and superior cava vein projected mostly on Th<sub>4</sub> (81.25%), in 12.5% of cases it projected on Th<sub>3</sub>, and in 6.25% of cases on Th<sub>5</sub>. The junction of the HV and the AV was found the most frequently (35.7%) at Th<sub>8</sub>, less frequently at Th<sub>9</sub> (18.7%), Th<sub>10</sub> (17.8%) and Th<sub>7</sub> (14.2%), and the most rarely (3.5%) at Th<sub>5</sub>, Th<sub>6</sub>, and Th<sub>11</sub>. The junction of the HAV and the AV was most frequent at Th<sub>7</sub> (41.6%), less frequent at Th<sub>6</sub> and Th<sub>8</sub> (29.2% and 25%), and least frequent at Th<sub>5</sub> (4.2%).

#### DISCUSSION

Knowledge of the variability of the azygos vein system is an important anatomical signpost in radiological diagnosis (CT and MRI) and in the surgical treatment of thoracic aorta aneurysms and tumours of the posterior mediastinum [2]. In our own research the AV was constantly observed, the HV in 84.4% of cases and the HAV in 80% of cases. These results correspond to the research of Seib [9], who found that of these 3 veins, there is most variability in the HAV and the least variability in the AV. Hitherto there have been only 6 cases of absence of the AV published in anatomical-radiological literature [1, 5], the intercostal area being drained by the HV, which terminated on the left brachiocephalic vein. In all these cases the increased venous flow on the left side caused the enlargement of the left intercostal superior vein, which appears on radiological films as a small triangular “aortic nipple”.

The single AV lying along the midline was observed in 9.4% of cases, and so was considerably more frequent than shown in Kadir’s statistics [6].

In the findings of Grzybiak et al. [4] the HV was presented in fetuses in 60% of cases, in newborns in 70% and in adults in 90%. The HAV was presented in 50% of fetuses and newborns and in 56% of adults, considerably less frequently than observed

in our study. Hyperplasia of the HV located between the aorta and the oesophagus was named the interazygos vein [2]. In Seib's material [9] this vein was observed in 3.6% of individuals.

In this study in 90.6% of cases the AV was located on the right side and the HV and the HAV were located on the left side of the vertebral midline. In the remaining cases (9.4%) the single AV lay along the midline, which does not conform to Kadir's statistics [6]. Kagami and Sakai [7] found that in the fetus the AV is located on the right side of the vertebral column (6 cases) or along the midline (4 cases), moving to the left side with age. This hypothesis would be confirmed by the fact that in their material the AV projected on the left side in 85% of adults. However, other authors [3, 8] have observed that the location of the AV along the midline is more frequent (27–96.3%) than on the right side of the vertebral column (3.7–53%).

The results of our research on the skeletopy of the azygos vein system correspond to data from literature. The termination of the AV projects on Th<sub>4</sub> and Th<sub>5</sub> [6, 7], termination of the HV projects on Th<sub>8</sub> [2, 6, 9] and termination of the HAV on Th<sub>7</sub> [6].

### CONCLUSIONS

1. There are 5 configurations of the azygos vein system.
2. There is least variability in the AV and the most variability in the HAV.

3. In human fetuses there is a right-sided (90.6%) or median (9.4%) location of the AV.
4. The termination of the AV projects most frequently on Th<sub>4</sub>, the HV on Th<sub>8</sub> and the HAV on Th<sub>7</sub>.

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