The Problems in the Arrangement of the Azygos Vein

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Summary: The azygos veins in thirty six cadavers (26 adult bodies, 10 human fetuses) were examined with special reference to the correlation with the midline of the vertebral column. The azygos veins were often observed to cross the middle of the ventral side of the vertebral column from right to left, and the occurrence of this crossing to the left is more frequent than that previously described — occurring in twenty two of the adult bodies. In three of the adult bodies, the vein ran upwards along the midline. In the remaining adult, the azygos vein ascended on the right side only of the vertebral column. In the fetuses, no azygos vein crossed the midline and the vein lay only on the right side or along the midline of the vertebral column. These results indicate the possibility of leftward displacement of the azygos vein during the ageing process.

Most of the old reports and anatomical textbooks described the course of the azygos vein. They considered the vein to ascend on the right side or slightly right of the midline of the vertebral column in normality (Gray 1919, Seib 1934). Some researchers, however, insisted that the azygos vein was found “more further to the left than has been indicated” (Schwartz et al. 1959) or “to run part of its course on the left side of the midline” (Nathan 1960). Recently, some anatomical textbooks have changed their description of course of the azygos vein (Gray 1989), but others have not (Woodburne and Burkel 1988, Grant 1989). Obviously there still remains some discrepancies in our knowledge about the arrangement of the azygos vein.

We occasionally found a case in which the azygos vein crossing the midline and ascended on the left side of the vertebral column. This case provided an opportunity for us to consider the question of the arrangement of the azygos vein. We therefore examined the azygos vein with special reference to its correlation with the midline of the vertebral column.

Materials and Methods

Thirty six bodies were dissected for this present work. Twenty six were dissecting-room cadavers (average age 79 years old), and ten were four to six month old human fetuses (average age 5 months). More details of these cadavers are shown in table 1.

| Table 1. The age distribution of cadavers used in this study |
|-----------------|-------|-------|-------|
| Age             | Male  | Female| Total |
|                 |       |       |       |
| 4 months        | 3     | 1     | 4     |
| 5 months        | 0     | 4     | 4     |
| 6 months        | 2     | 0     | 2     |
| Total           | 5     | 5     | 10    |

Observations

In the adult bodies, twenty two cases showed the azygos vein crossing the midline of the vertebral column to the left. In three cases, the azygos veins reached the midline of the vertebral column and only in the remaining case did the azygos vein ascend only on the right side of the vertebral column.

In the fetuses, most of the azygos veins were located slightly right of the midline (6 cases) or along the midline of the vertebral column (4 cases). Azygos veins which crossed the midline to the left side were not observed. The arrangement of this vein in the fetuses confirmed with the previous descriptions. But the
course of the azygos veins in the adult bodies were very different from the courses previously described.

Observing the whole course of the individual azygos veins in adult bodies, we noticed that the course of this vein can be divided into two types.

The first type shows a semicircular course. In this type, most begin on the right side or near the midline of the vertebral column, run obliquely to cross to the left side at the level of the 9th to the 12th thoracic vertebrae, ascend on the left side and return obliquely to the right side at the level of the 3rd to the 6th thoracic vertebrae. The veins then ascend straight or sometimes curve slightly to the left for a short distance and end in the superior vena cava. Veins of this type are characterized by a leftward convex curve within their course and overall have a sigmoid configuration. A typical vein of this type is shown in Fig. 1. These sigmoid azygos veins were observed in fourteen of the adult bodies. In these fourteen cases, twelve crossed to the left side of the vertebral column, another lay near the midline and the remaining ascended on the right side of the vertebral column.

The second type of azygos veins have a much straighter course than the sigmoid type. They always begin at the right side of the vertebral column, cross to left at a lower level (the 10th to the 12th thoracic vertebrae) than the sigmoid type, ascend straight, and return to the right side in the upper portion (the 3rd to the 6th thoracic vertebrae) to end in the superior vena cava. This type shows a straight form with none of the convex curves characteristic of the sigmoid type. A vein typical of this type is shown in Fig. 2. This type of azygos vein was observed in twelve adult bodies. In ten cases the veins crossed to the left side, and in two cases the veins lay along the midline of the vertebral column.

The whole course of the azygos vein was also examined in the fetuses, and in all cases the azygos veins showed straight lines and the sigmoid type was not observed (Figs. 3, 4).

Osteophytes of the vertebral bodies are generally observed in adults especially in old people. We noted their relationship to the course of the azygos veins. In this study, sixteen adult bodies had osteophytes on the front of the vertebral bodies, and in all of these, the azygos vein crossed to the left side. However, in seven adult bodies without osteophytes, the azygos veins also drained on the left side. In the remaining three cases without osteophytes, the azygos veins drained near the midline or on the right side of the vertebral column.

**Discussion**

In this study, a high ratio of the azygos veins were observed to drain on the left side of the vertebral column - more than 80%. In previous papers the reported ratios vary widely, for example, Fukutome (1951) observed it in 3.7%, Tateshi (1939) in 18% and Nathan (1960) in 53% (Table 2). There is no satisfactory explanation of this discrepancy among these reports.

We speculate that the degenerative or pathological changes during ageing process might influence the course of the azygos vein to displace, and consider it as one of the possible explanation of this discrepancy. In the human body the significant change observed in the mediastinal region especially in old people is the elongation of the aorta. It is believed that the arteries show elongation as part of the ageing process (Caird and Dall 1973) and in some, like the aorta, the elongation was thought to cause the deviation of the azygos vein in a possibility (Nathan 1960). Our results gave support to his idea and regarded this as the most significant factor for azygos vein displacement. In fact our investigation showed that the azygos vein and the aorta are surrounded together by dense connective tissue and generally located parallel to each other. Fig. 2 shows examples of such cases. We observed more azygos veins showing the sigmoid shape than ever reported (Adachi 1940, Falla 1963) and we believe that these cases result from an elongated and sigmoid shaped aorta. Adachi (1940) also reported cases which had displaced azygos veins, and explained it as a part of the ageing process especially in older people.

To prove that the course of the azygos vein correlates with the aorta, further evidence will be required. However, our supposition is that the displacement of the aorta during aging influences the course of the azygos vein.

Other evidence for this hypothesis is the fact that in this study no fetus was found to have the azygos vein crossing to the left side. Rokutanda (1950) reported the ratio of left sided veins in 2% of fetuses and this ratio in stillborn infants was reported as 15% by Nathan (1960). That sigmoid azygos veins were not observed

| Table 2. Ratio of the azygos vein concerning its course |
|---------------------------------------------|-----------------|---------------|-----------------|-----------------|
|                                      | Total (cases) | Right (%) | Middle (%) | Left (%) |
| Kagami, H. (1989)                     | 10 60 | 40 | 0                  | 5M*               |
| Rokutandaa, R. (1950)                 | 50 30 | 68 | 2                  | 6M                |
| Nathan, H. (1960)                     | 20 70 | 15 | 15                 | stillborn infants |
| Fukutome, M. (1951)                   | 54 0  | 96.3 | 3.7              | 42Y**             |
| Tateshi, S. (1939)                    | 11 18 | 64 | 18                 | 55Y               |
| Nathan, H. (1960)                     | 69 20 | 27 | 53                 | not examined      |

* M: months old **Y: years old
in fetuses in our study we regard as being supportive evidence for our theory.

If we follow this hypothesis, we must regard age as being one of the essential factors influencing the course of the azygos vein. In the adult bodies, the incidence of left sided azygos veins varied with age (Table 2). The average age of the cadavers in this study is 79 years which may be much higher than that of the bodies in former investigations.

Nathan (1960) stated that osteophytosis along the vertebral column is a generalized phenomenon with advancing years. It is considered to be caused by the mechanical stresses and strains acting on the vertebral column. He discussed the relationship between the osteophytes and the course of the azygos vein in his report.

However, we did not obtain any evidence for the influence of osteophytes on the displacement of the azygos vein. In this study, osteophytes on the vertebral bodies were observed frequently. Veins crossing to the left side and vertebral osteophytes were often observed in the same specimen. In some cases the azygos veins seemed to accompany these osteophytes. However, in other cases of azygos veins ascending on the left side of the vertebral column, there was no relationship to osteophytes which were absent in these cases. From these results, it may be concluded that the course of the azygos vein is not influenced by osteophytes, but rather that osteophyte development would be influenced by the course of the azygos vein or other stout tissues like the aorta.

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References


Abbreviations:
AO: aorta of adult body
AZ: azygos vein of adult body
HA: hemiazygos vein of adult body
az: azygos vein of fetus
ha: hemiazygos vein of fetus
Explanation for Figures

Plate 1

Fig. 1. Sigmoid azygos vein and hemiazygos vein of 87-year-old female.
Fig. 2. Straight azygos vein along with aorta observed in 93-year-old male.
Fig. 3. Straight azygos vein and hemiazygos vein of 5-month-old fetus.
Fig. 4. Straight azygos vein of 5-month-old fetus.