

Original communication

Azygos Lobe in a South African Cadaveric Population

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Total number of figures: 2

Total number of tables: 2

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ABSTRACT

Knowledge of the prevalence, morphology and location of the azygos lobe is essential for diagnostic and surgical procedures of the lungs related to mediastinal pathologies, especially to minimize intraoperative vascular injuries, shock, possible thoracotomy and even the possibility of pulmonary torsion. Reports on the prevalence of the azygos lobe vary between 0.11% and 0.43%. The aim of the current study was to record the prevalence and morphological description of the azygos lobe in the South African cadaveric population. A total of 704 adult cadavers dissected over a ten-year period by students in the Department of Human Anatomy at the Medunsa Campus, University of Limpopo, were studied. The prevalence and dimensions of the azygos lobe were determined with a 95% confidence interval. Results indicate that an azygos lobe was present in the right lung in only four cases (prevalence 0.57%, 95% Confidence Interval [CI]: 0.2%-1.6%). The mean height and width were 6.7 cm (95% CI: 4.4-9.2) and 4.5 cm (95% CI: 3.7-5.2) respectively. Observations on the morphology of the azygos lobe showed that it was rectangular (n=3) and triangular (n=1) in shape with smooth margins. In conclusion, the azygos lobe is a rare anomaly in the South African cadaveric population. The present results are comparable with those reported in the literature for other populations. Future radiological studies on the azygos lobe on living subjects in South Africa will be useful for further understanding of this rare but significant anomaly.

Key words: azygos lobe, accessory azygos lobe, pulmonary azygos lobe, azygos anomaly, cadavers

INTRODUCTION

The azygos lobe is a rare but significant anomaly of the lung (Gill et al., 2004; Moon et al., 2005). A thorough understanding of the azygos lobe is essential for minimizing intraoperative vascular injury, blood loss and other complications during thoracic surgery, especially during a sympathectomy (Sieunarine et al., 1997; Gill et al., 2004). Furthermore, the presence of the azygos lobe makes video-assisted thoracoscopic surgery difficult (Sadikot et al., 1957). Moon et al. (2005) reported cases where surgery had to be postponed when an azygos lobe was identified on radiographs as surgeons feared complications arising during surgical procedures. Important clinical considerations for the anesthesiologist include hypovolemic shock due to bleeding, possible thoracotomy and even the possibility of pulmonary torsion (El-Dawlatly and Al-Dohayan, 2006).

The presence of an azygos lobe may also be associated with other anomalies such as esophageal atresia (Eradi and Cusick 2005), intrapulmonary right brachiocephalic vein (Arslan et al., 2000) and extrapulmonary sequestration in the upper posterior mediastinum (Koksal et al., 2007). Furthermore, anatomical knowledge of the azygos lobe is important for understanding the uncommon opacity that may be visualized on a chest radiograph and thus avoiding confusing it with any other significant abnormality or pathology. In addition, the recognition of this lobe is necessary for avoiding misinterpretation of radiological findings in the presence of pulmonary diseases (Caceres et al., 1993; Saeed et al., 2002). In chest X-rays the azygos lobe may appear as a comma-shaped or a horse-shoe-shaped curved thin shadow, starting from the upper border of the lung, curving outwards, downwards and finally inwards (Underwood and Tattersall, 1933).

The azygos lobe was first recognized at an autopsy study in 1777 by Wrisberg at Gottigen, in present-day Germany (Wrisberg, 1778). Wrisberg's observation was made on the

cadaver of a three-year-old boy, in whom the azygos lobe was present in both lungs. Various names were assigned to the azygos lobe, including “lobe of Wrisberg” (Wrisberg, 1778), “lobe of the azygos vein” (Weston, 1954), “accessory pulmonary lobe of the azygos vein” (Anson and Smith, 1936; Crawford, 1944; Anson et al., 1950), and azygos lobe (Crawford, 1944). Besides the various names given to the azygos lobe, numerous descriptions have also been provided. For example, Wrisberg (1778) described this lobe as being separated from the remainder of the apex of the right lung by a fissure containing the azygos vein or the left superior intercostal vein.. Crawford (1944) described it as a malformation of the upper lobe of the right lung, lying between the mediastinum and the curve formed by the azygos vein, which is embedded in the lung. Weston (1954) described it as a malformation of the right upper lobe, cut off from the upper and medial part of the lung just above the hilus by a fold of parietal pleura containing the azygos vein.

Current anatomy textbooks do not mention the azygos lobe at all. The azygos lobe is a developmental anomaly. The reason for its occurrence during the development is unknown. It may be genetic, as there are cases where an azygos lobe has been reported in families (Pipkin et al., 1952; Postmus et al., 1986). Furthermore, as a matter of interest, the literature mentions another accessory lobe of the lung called the “inferior accessory lobe”. This is another rare anomaly of the lung (Soper, 1933).

A survey of the literature indicates that the prevalence of the azygos lobe varies from 0.11% to 0.43% (Underwood and Tattersall, 1933; Clive, 1943; Adachi, 1940; Ashbury et al., 1942; Anson et al., 1950; Boyden, 1952). There is no reported study in South Africa of the prevalence of the azygos lobe. The aim of the present study was to record the prevalence of the azygos lobe in the South African population and to describe its morphology.

MATERIALS AND METHODS

This study was carried out over a ten-year period (1994 to 2003) and included a sample size of 704 (539 black males, 152 black females, eight white males, two white females, one colored male and two colored females) adult cadavers. The dissections were performed by medical students under the supervision of the researcher and trained anatomists, in the Department of Human Anatomy at the Medunsa Campus, University of Limpopo (in accordance with the Human Tissue Act No. 65 of 1983). The right and left lungs of each cadaver were examined and the presence or absence of an azygos lobe was recorded onto an Excel spreadsheet. The prevalence of the azygos lobe was then expressed as a percentage with its 95% confidence interval, which was established through the use of the Wilson's score method. This statistical method was used as it was appropriate for finding confidence intervals when the observed prevalence was close to zero or 100 percent. The dimensions measured included the height and width of the azygos lobe. The height was recorded from the midpoint of the superior to the midpoint of the inferior margin. The width was measured from the midpoint of the posterior to the midpoint of the medial margin (see Fig. 1). The mean, standard deviation and 95% confidence interval for height and width were calculated using the SPSS version 14 for Windows.

The morphological description of the azygos lobe was provided *in situ*. Descriptions included the shape and edges of the azygos lobe, its location on the right or left lung, the relationship with other lobes of the lung and mediastinum, the depth of fissure separating the azygos lobe from the rest of lung, and the presence or absence of the azygos vein in the fissure. Furthermore, the course of the azygos vein in the fissure separating the azygos lobe from the rest of the lung and its emptying into the superior vena cava or into another vein were also recorded.

The vascular and bronchial supply of the azygos lobe was dissected away from the surrounding pulmonary tissue to establish the correct size of the azygos lobe. Ethical clearance and approval for this study was obtained from the Ethics Committee of the Medunsa Campus of the University of Limpopo.

RESULTS

Out of the 704 cadavers, only four (prevalence 0.57%, 95% Confidence Interval [CI]: 0.18%-1.55%) were identified as having an azygos lobe in the right lung. None of the cadavers had bilateral azygos lobes. No azygos lobes were found in the left lungs. The azygos lobe was identified in one white cadaver and three black cadavers. The prevalence of the azygos lobe in South African male and female cadavers is shown in Table 1. The azygos lobe was present in three out of a total of 548 males (prevalence: 0.55%; 95% CI: 0.1%-1.7%). Only one case was observed in a sample of 156 females (prevalence: 0.64%; CI: 0.03%-4.1%).

Table 1: The prevalence of the azygos lobe in South African male and female cadavers (N=704)

Gender	N	n (%)	95% Confidence Interval
Male	548	3 (0.55)	0.1-1.7
Female	156	1 (0.64)	0.03-4.1
Total sample	704	4 (0.57)	0.2-1.6

N = sample size

n = number of cases with the azygos lobe present

The dimensions of maximum height (cm) and maximum width (cm) of the azygos lobe in all four cases are shown in Table 2. The value of the height ranged from 5.0 cm to 8.5 cm and the width from 4.0 cm to 5.0 cm. The average height and width dimensions were recorded as 6.7 cm (95% CI: 4.4-9.2) and 4.5 cm (95% CI: 3.7-5.2) respectively.

Table 2: Dimensions (cm), plus mean value, standard deviation (sd) and confidence interval (CI) of the azygos lobes in a South African cadaveric population (N=4)

Number of cases	Height (cm)	Width (cm)
1	8.5	5.0
2	6.3	4.2
3	5.0	4.0
4	7.0	4.6
Mean (sd)	6.7 (1.46)	4.5 (0.44)
95% CI	4.4 – 9.2	3.7 – 5.2

Observations on the morphology of the azygos lobe showed that the lobe was rectangular in shape (n=3) with four margins; namely, the superior, inferior, posterior and medial margins (Fig. 1). All the margins were straight with the exception of the medial margin, which projected

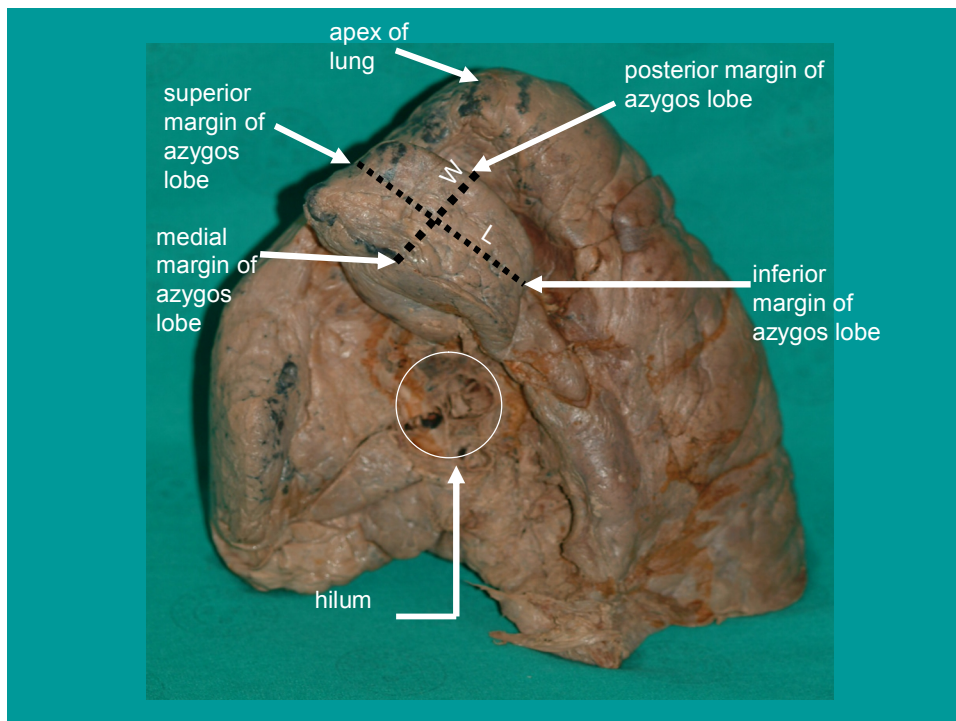


Fig. 1: Mediastinal surface of the right lung showing the rectangular-shaped azygos lobe. The broken lines indicate the length (L) and width (W) measurements

medially, ending with a rounded tip. In one case the azygos lobe was triangular in shape with a broad base inferolaterally and narrow apex superomedially (n=1). The outer margins were smooth. The lobe was identified on the right lung by a fissure passing through the apex of the lung. In all observed cases, there was no separate hilus for the azygos lobe.

The relation of the azygos lobe to the rest of the right lung is as follows: superior margin to lung apex, inferior margin to the diaphragmatic lung surface, posterior margin to posterior lung border, and medial margin towards the mediastinal surface.

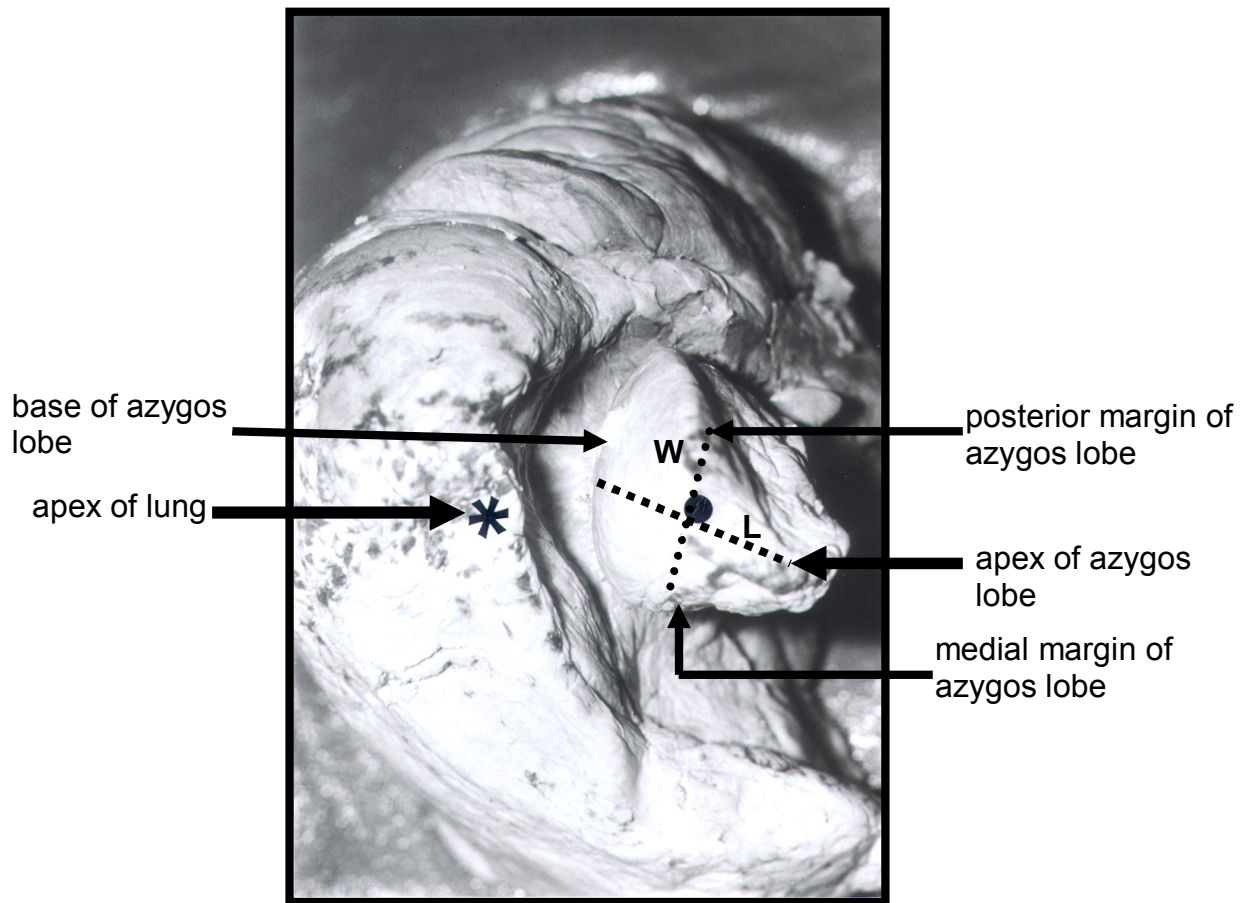


Fig. 2. Superior view of the right lung showing a triangular-shaped azygos lobe. The broken lines indicate the length (L) and width (W) measurements

In all four cases the azygos lobe had the posterior margin attached to the superior lobe of the right lung while the unattached part of the azygos lobe was separated from the apex of the lung by a vertical fissure which extended from the apex towards the attached part of the azygos lobe. The depth of the fissure varied from 3 cm to 5.5 cm and it contained the azygos vein. The azygos vein coursed through the azygos fissure and ended by draining into the superior vena cava (n=3) and into the right brachiocephalic vein (n=1).

DISCUSSION

There are no reports of studies in the literature on the azygos lobe in the South African population. The present study showed a prevalence of 0.6% of the azygos lobe in the South African population, indicating a fairly uncommon occurrence in this group. A review of the literature indicates that these results are comparable with those reported by authors for other populations. Adachi (1940) reported a 1.06% prevalence of the azygos lobe in the German cadaveric population as compared to 0.14% in the Japanese cadaveric population. Anson et al. (1950) reported a 0.43% prevalence of the azygos lobe in the American cadaveric population. Boyden (1952) reported only one case of azygos lobe out of 500 cadavers (0.2%), dissected in the Department of Anatomy at the University of Minnesota in the United States. Reported radiological studies also show low prevalence, such as 0.2% in Rotherham, (Underwood and Tattersall, 1933), 0.13% in the American Army (Ashbury et al., 1942) and 0.11% in Great Britain (Clive, 1943). Besides the above-mentioned anatomical studies on cadavers and radiological studies on living subjects, Civetta and Daggett (1968) reported two case studies of surgical resection of the azygos lobe in patients with advanced tuberculosis, in Middlesex County Sanatorium and Gill et al. (2004) reported a case study of an azygos lobe found during a

thoracic sympathectomy in a vascular surgical unit in Leeds in the United Kingdom. In a nutshell, this anomaly is rare in the South African population as well as the rest of the world.

There was no azygos lobe observed in the left lung in our study. This is consistent with Felson's (1989) statement that the prevalence of an azygos lobe in the left lung was much lower than for the right lung. Felson (1989) and Hanke (1967; 1968) were of the opinion that most if not all the reported cases of a left-sided azygos lobe might in fact have been bullae. On the contrary, case studies of the azygos lobe in the left lung have been reported by Weston (1954) and Boyden (1955). Boyden (1955) based his report on anatomical studies while Weston (1954) based his findings on radiological investigations.

Results of the height and width measurements in the current study could not be compared to other studies as these dimensions were not reported for other populations. Felson (1989) described azygos lobes that varied in size, similar to those observed in the present study. However, he did not provide exact measurements. Felson (1989) also described the azygos fissure as extending towards the lateral thoracic wall, a feature not seen in the current study. The entry of the malpositioned azygos arch into the right brachiocephalic vein rather than into the superior vena cava reported by Felson (1980) was also seen in one case in the present study.

The azygos fissure may be complete or incomplete and it may also extend towards the hilum of the lung at various depths (Yildiz et al., 2004). In the present study, the azygos fissure was complete in all four cases and it extended towards the hilum of the right lung at various depths as described by Yildiz et al. (2004) and Ozmen et al. (2010).

Although more than 700 cadavers were examined in the present study only four had an azygos lobe. One would expect that with a larger sample size the extent of the variability would also be less. The small standard deviation in relation to the mean value is an indication that the

amount of variation that exists is reduced. The standard deviation relative to the mean was less than 35% in this study thus the 95% confidence interval could be considered to be valuable using the Wilson's score method.

In this study the majority of cadavers were black South Africans in keeping with the demographics of the country. On the other hand, no conclusions can be made on the prevalence of the azygos lobe in the white population of South Africa owing to the small sample size. Irrespective of the small sample size of one group, it can be concluded that this study is of importance because the azygos lobe has been shown in the literature to be a clinically significant anomaly (Gill et al., 2004; Moon et al., 2005). Clinicians' awareness of the azygos lobe is essential for diagnostic and surgical procedures of the lungs and mediastinal pathologies (Saeed et al., 2002).

CONCLUSIONS

In conclusion, the presence of an azygos lobe is a rare anomaly in the South African population. The present results are comparable with those reported in the literature for other populations. Future radiological studies on the azygos lobe on living subjects in South Africa would be useful for further understanding of this rare but significant anomaly.

ACKNOWLEDGEMENTS

The authors would like to thank Prof Andy Mogotlane, previously Head of the Department of Human Anatomy, Medunsa Campus, University of Limpopo, for allowing us access to the cadavers and for his clinical advice during the initial stages of this study. We are also grateful to Prof Piet Becker from the Department of Biostatistics, Medical Research Institute, University of

Pretoria, for his statistical guidance. Our sincere thanks go to Prof Anwar Hoosen of the Department of Microbiology, University of Pretoria, for his valuable comments on the manuscript.

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