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Microanatomy of glomic tissue of the pulmonary trunk

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Glomic tissue occurs at the bifurcation of the pulmonary trunk. There is controversy as to its derivation, blood supply, and function. It has been regarded as one of the coronary glomera supplied by the intertruncal branch of the left coronary artery. On the other hand, it has been described as the true glomus pulmonale supplied by blood from the pulmonary trunk. The purpose of this article is to draw attention to its existence and to establish its microanatomical structure.

Many glomera are present around the heart and great vessels. One of them is present on the dorsal aspect of the bifurcation of the pulmonary trunk. Krahl (1960) found its situation there so constant that he designated it 'the glomus pulmonale', believing it to be supplied by blood from the pulmonary trunk. He has since reported pulmonary glomera in the cat, dog, rat, cow, and chimpanzee (Krahl, 1962). Becker (1966), on the other hand, does not believe that a glomus pulmonale exists as such. He considers that it is one of the coronary glomera situated between the ascending aorta and the pulmonary trunk in ventral as well as dorsal positions and supplied by a branch of the left coronary artery called the intertruncal artery. The glomus described by Barnard (1946) in relation to the ductus arteriosus probably represents one of these coronary glomera. Since there is disagreement as to the blood supply of the glomic tissue closely applied to the pulmonary trunk, it is not surprising that its functional significance is also highly controversial. The purpose of this article is to draw attention to the existence of glomic tissue on the pulmonary trunk and to describe its microanatomy.

MATERIAL

The case studied was that of a man aged 56 years who died of myocardial ischaemia due to coronary occlusion.

METHOD

The pulmonary trunk and the proximal portions of the right and left main pulmonary arteries were resected en bloc and opened with scissors anteriorly. This tissue was then immersed in a 1% solution of methylene blue to stain nerve fibres. A block of tissue was removed just posterior and caudal to the bifurcation where there appeared to be a small plexus of nerves. This block was fixed in 10% formalin and subsequently embedded in paraffin wax. Sections 5 μ in thickness were cut at 50 intervals of 50 μ throughout the block so that a total length of 2·5 mm. of pulmonary trunk was examined. Glomic tissue was found in the adventitia of the pulmonary trunk immediately posterior and caudal to the bifurcation in consecutive sections cut at 15 of the 50 intervals. Thus glomic tissue extended over a distance of 700 μ. At each of these 15 intervals, which we shall call levels 1 to 15 for brevity of description, three sections were cut. The middle section was stained with haematoxylin and eosin to demonstrate the general structure of the glomic tissue. One adjacent section at each level was stained with Verhoeff's and Van Gieson's stains to demonstrate elastin, muscle, and collagen and thus to reveal the structure of the blood vessels taking part in the formation of the glomus. The other adjacent section at each level was stained by Gordon and Sweet's method to demonstrate the reticulin pattern present.

RESULTS

The margins of the glomic tissue were ill-defined and so the dimensions quoted in the following description are only approximate.

LEVEL 1 An artery, 200 μ in diameter, entered the peri-adventitial adipose tissue of the pulmonary trunk obliquely. It had a media of circular smooth muscle bounded by internal and external elastic laminae. It was accompanied by prominent nerve fibres. Within the adventitia of this artery was a capillary vessel with glomic cells in its wall

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which appeared to be derived from glomic tissue found in the next level.

LEVEL 2 The artery suddenly terminated in a glomus of small capillary blood vessels as shown in Figure 1. Other masses of glomic tissue were found laterally in the adventitia of the artery. At this level there was a considerable amount of elastic tissue in the media of the artery. The elastic fibrils were somewhat haphazardly arranged, but up to five main laminae could be distinguished.

LEVEL 3 (Fig. 1) At this level the diameter of the parent artery had diminished to 180 μ. The terminal mass of glomic tissue was more defined and prominent, measuring 480×190 μ.

LEVEL 4 There was intimate association of the parent artery and the glomic tissue in its adventitia which now formed an eccentric nodule measuring together with the vessel 370×240 μ (see Fig. 2).

The internal and external elastic laminae of the artery were not well defined and the elastica of the media was haphazard in its arrangement. The pathway of blood from the parent artery into the glomic capillaries appeared to be by way of arterioles, one of which was seen in the section. Only the outer elastic lamina was distinct in the arterioles. The glomic tissue was composed largely of capillary blood vessels lined by plump endothelial cells, some of which bulged into the capillary lumina. Two types of cell were seen in the intercapillary tissue. One type was large with ill-defined cytoplasmic borders; it had large, pale-staining, vesiculate nuclei. In section some of these nuclei were round while others were oval; a few were nodular in outline. The nuclei contained compact, darkly-staining granules and thin strands of material surrounding pale areas which appeared to be vacuoles. These cells appeared to be chief cells or 'light cells.' Also present were smaller cells with more compact rounded nuclei; these were the so-called 'dark cells'.

FIG. 1. *Level 3. The parent artery enters the outer adventitia of the pulmonary trunk (left). Its media is bounded by distinct internal and external elastic laminae and includes many small haphazardly arranged elastic fibrils. To the right it suddenly terminates in a mass of glomic tissue. Note the prominent nerve fibres (indicated by arrows) above and below the artery. (Verhoeff's elastic and Van Gieson's stains. The magnification of this and the remaining figures is* $\times 180$.)

LEVEL 5 (Figs 2 to 4) There was a continuation of the adventitial glomic tissue. The reticulin pattern was similar to that of the carotid body (Fig. 3). A small nerve ganglion was found adjacent to the glomus in this section (Fig. 4).

LEVEL 6 (Fig. 5) This section contained a prominent arteriole, and there was also prominence of the capillaries of the glomus which at this level extended over an area of 460×280 μ. The glomic tissue was still intimately associated with the parent artery. This artery still showed multiple elastic laminae in its media.

LEVEL 7 The glomic capillaries remained prominent but the intervening glomic cells were less in evidence.

LEVEL 8 (Fig. 6) At this point the glomus 710×310 μ, began to separate from its parent artery. The artery at this level still had a media of circular smooth muscle, with internal and external elastic laminae. There was fuzziness and elastosis of the internal elastic lamina.

LEVEL 9 The glomus measured 530×260 μ at this level, and contained only sparse glomic cells. It consisted largely of capillaries and arterioles. The glomus was in juxtaposition to nerve fibres.

LEVEL 10 (Fig. 7). The margins of the glomus, 620×620 μ, became less defined. The capillaries remained prominent.

LEVEL 11 Here the histological appearances changed abruptly. The capillary enlargement noted in previous levels suddenly became accentuated with the development of large clefts and spaces. Intervening glomus cells were much in evidence. Well-defined precapillary vessels were found at the edge of the glomic tissue. At this level a section of the glomus measured 530×400 μ.

LEVELS 12 (Fig. 8), 13, and 14 Over these levels the glomus diminished in size from 620×530 to 570×440 μ. All showed the same combination of

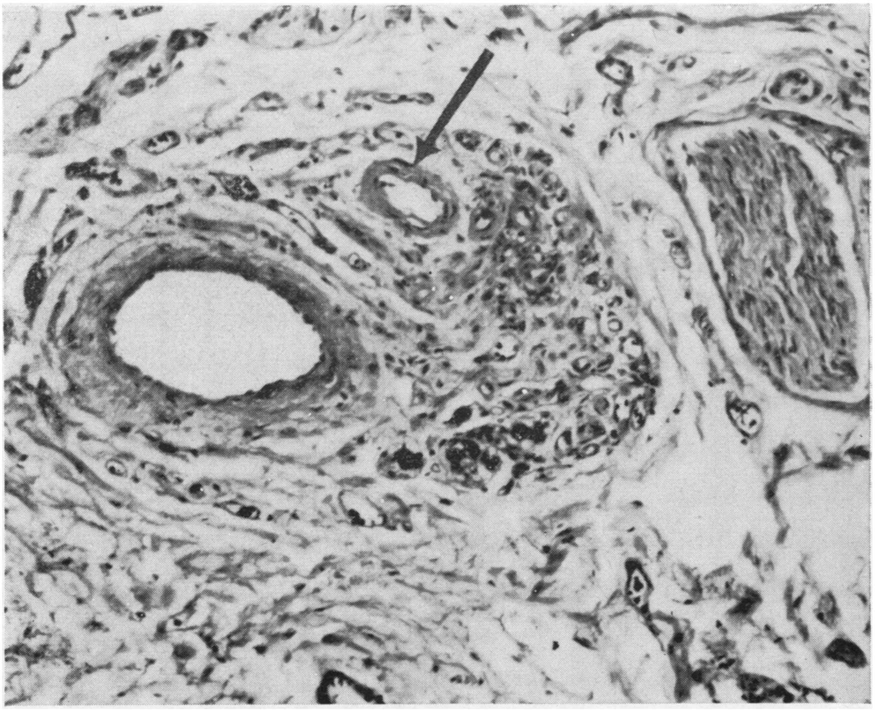

FIG. 2. *Level 5. The parent artery is seen to the left, where it has been cut in transverse section. Above it and to its right is an arteriolar branch, also cut in transverse section (arrow). This arteriole supplies a nodule of glomic tissue consisting of capillaries with surrounding glomic cells. Note the prominent nerve fibre to the right of the glomus (Haematoxylin and eosin).*

arterioles, clefts, capillaries, and glomus cells as noted in the section from level 11.

LEVEL 15 (Fig. 9). Glomic tissue ended here. The capillaries formed tributaries of thin-walled venules which separated, expanding the size of the mass to $1{,}060 \times 530\ \mu$. The draining veins became more thick-walled and dispersed into surrounding adipose tissue. In this manner the glomus terminated.

DISCUSSION

Our study confirms the presence of glomic tissue closely applied to the adventitia of the pulmonary trunk. The ease with which we found this tissue in the exact position predicted by Krahl (1962) supports his contention that a glomus exists in a constant site on this vessel. Krahl (1962) predicted that a homologue of the carotid and aortic bodies should be associated with the pulmonary trunk, since this was a representative of the sixth branchial arch for which a glomus had not been described. His personal views based on phylogenetic and ontogenetic considerations as to the branchial arches related to each of the glomera described so far are summarized in the Table. Finding that his prediction of glomic tissue at the bifurcation of the pulmonary trunk was confirmed, he designated this tissue the 'glomus pulmonale'. Becker (1966) disagrees with this view.

TABLE

ARTERIES, NERVES, AND BRANCHIAL ARCHES ASSOCIATED WITH THE GLOMERA OF THE HEAD AND NECK, ACCORDING TO KRAHL

Glomus	Branchial Arch	Artery	Nerve
Glomus jugulare	2		Vagus or glossopharyngeal or facial
Carotid body	3	Bifurcation of common carotid artery	Glossopharyngeal
Aortic glomus	4	Aortic arch	Vagus
Aorticopulmonary bodies	(5) Fails to persist	No vascular derivatives. Shift in blood supply from pulmonary trunk to aorta after birth	Vagus
Glomus pulmonale	6	Bifurcation of pulmonary trunk	Vagus

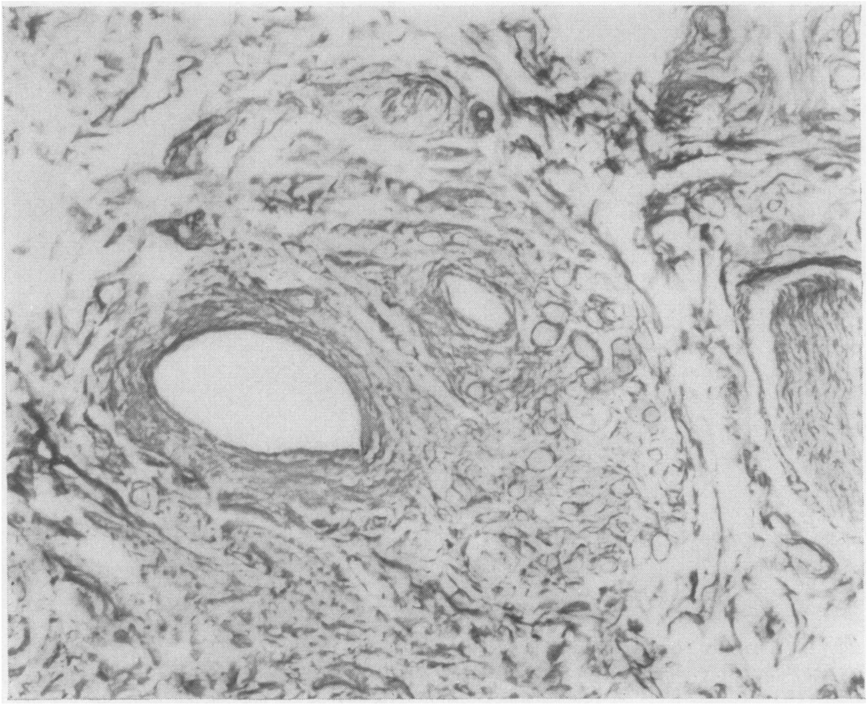

FIG. 3. *Level 5. This is an adjacent section to that illustrated in Fig. 2 and reveals the reticulin pattern of the glomus and its blood vessels (Gordon and Sweet's reticulin stain).*

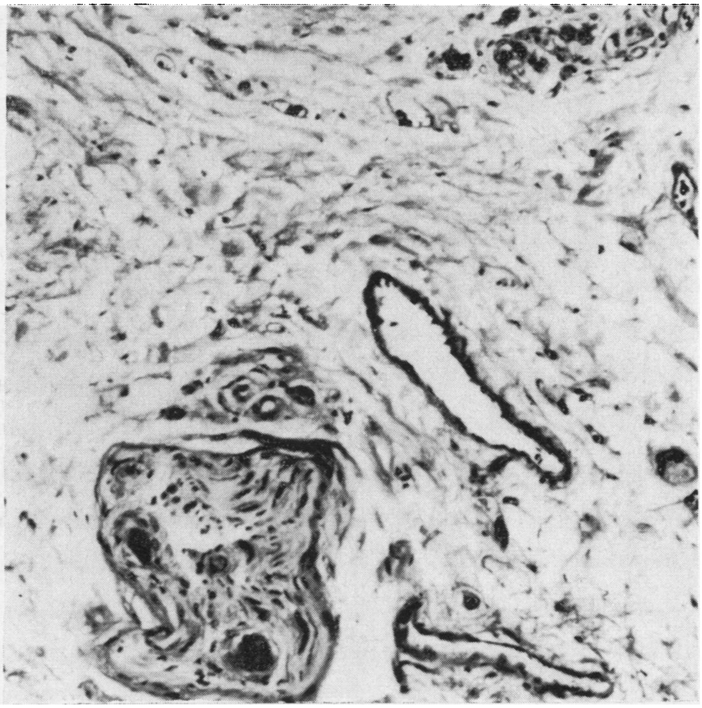

FIG. 4. *Level 5. A nerve ganglion is situated in proximity to the glomus, the edge of which is seen at top right. This portion of glomic tissue corresponds to the right lower edge of the glomus included in Figure 2 (H. and E.).*

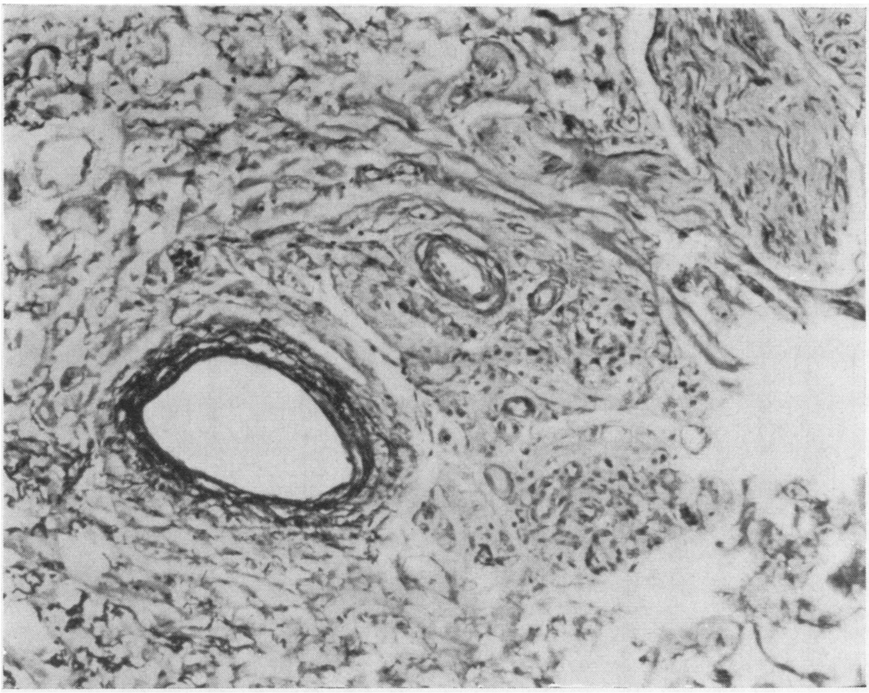

FIG. 5. *Level 6. This is an adjacent section to that shown in Fig. 2 and reveals the elastic tissue configuration of the blood vessels of the glomus (V.V.G.).*

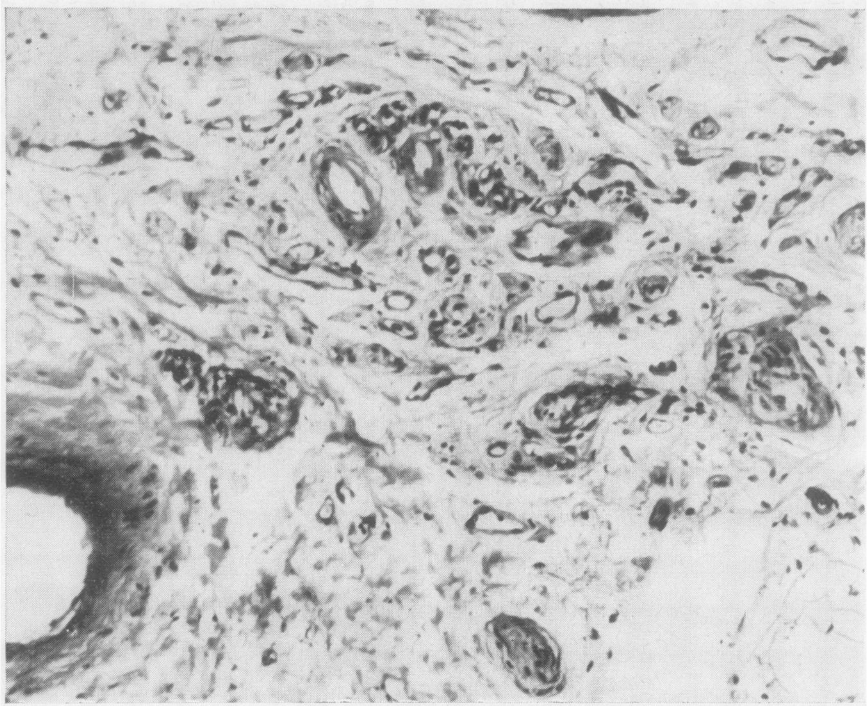

FIG. 6. *Level* 8. *At this level arterioles and capillary vessels are more prominent than glomus cells. Only part of the glomus is shown in this figure* (*H. and E.*).

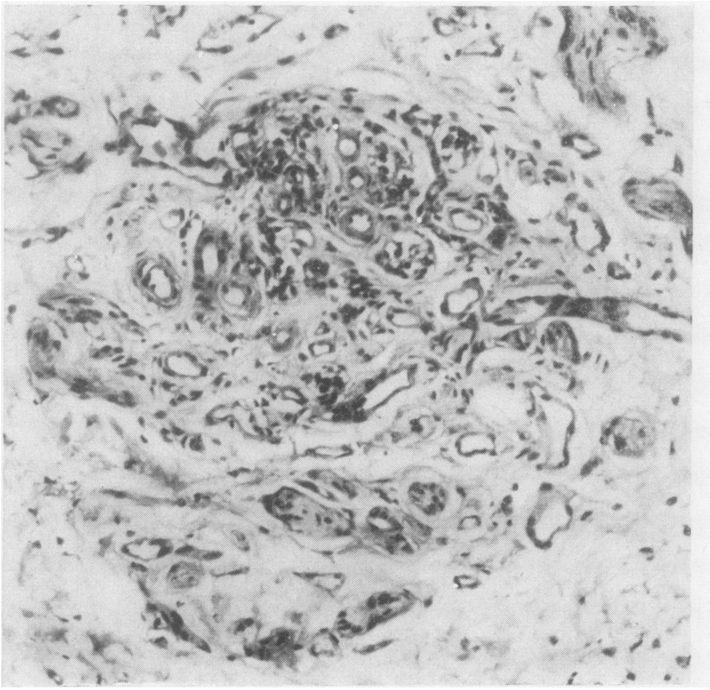

FIG. 7. *Level* 10. *The glomus is now separated from its parent artery. It consists of arterioles and capillary blood vessels with closely surrounding glomic cells* (*H. and E.*).

From a meticulous study of the glomera in the region of the heart, ascending aorta, and pulmonary trunk in man and in the rabbit, he considers the glomus on the pulmonary trunk to be one of those which he terms the coronary glomera. He defines these as glomera localized between the ascending aorta and pulmonary trunk in both ventral and dorsal positions. They are to be distinguished from the aortic glomera bounded by the aortic arch, ductus arteriosus, and right pulmonary artery.

The results of our study confirm that the glomic tissue on the pulmonary trunk bears a close histological resemblance to the carotid body and other glomera. Its microanatomical structure is certainly consistent with its subserving a chemoreceptor function because, as we have shown, it consists of an artery which splits up into arterioles to feed a complex capillary vascular network closely surrounded by the parenchymal cells of the glomus. Such microanatomical appearances suggest that these glomic cells come into contact with a copious blood supply because the size of the parent artery is large in comparison with the minute dimensions of the nodule of tissue supplied. Furthermore, the glomic cells are separated from this rich blood supply only by the endothelial cells of the capillaries and by associated pericytes.

Glomic cells in the carotid body of the cat and rabbit have been studied by Lever, Lewis, and Boyd (1959). They found that these cells contained osmiophilic, membrane-bound, granular bodies, 0·05 to 0·15 μ, in the cytoplasm. 'Dark' glomic cells contain many of these granules and have compact mitochondria, while in 'light' cells the cytoplasmic matrix is less dense with fewer granules and grossly vacuolated and distended mitochondria. The histochemical reactions of the granules suggested that they contain phenolic amines. These findings led Lever *et al.* to postulate a local humoral role for the glomic cells. They believe that a stored form of catechol amine is released from the granules by various stimuli to affect adjacent nerve terminals. Among the possible stimuli listed by these authors was 'anoxia'.

It is now well established that glomus cells in the carotid body act as detectors of chemical changes in the blood, since the classical papers of

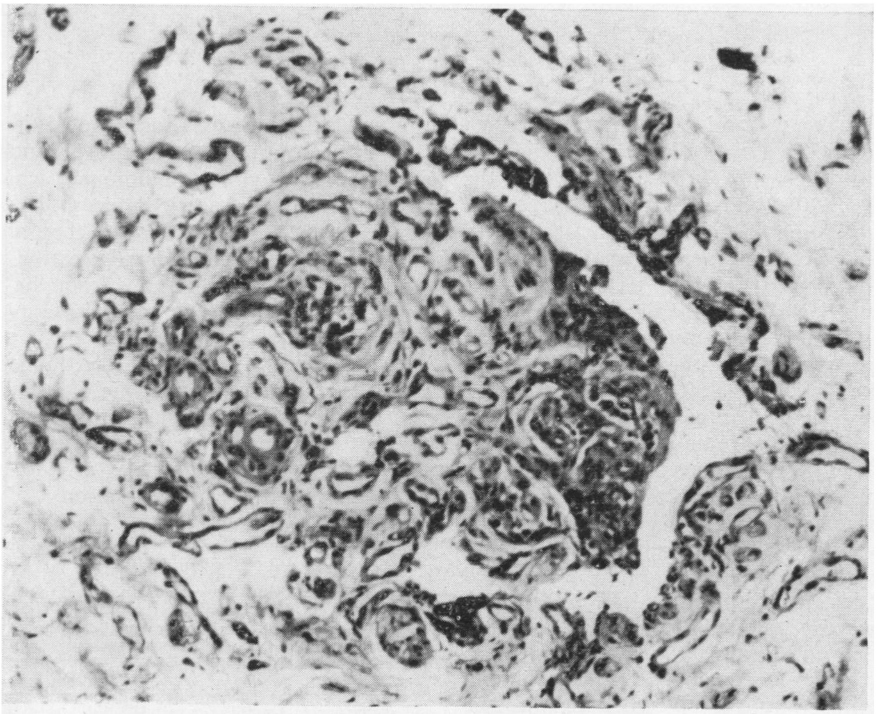

FIG. 8. *Level 12. Prominent clefts, representing tributaries of veins draining the glomus, are present in the mass of glomic tissue (H. and E.).*

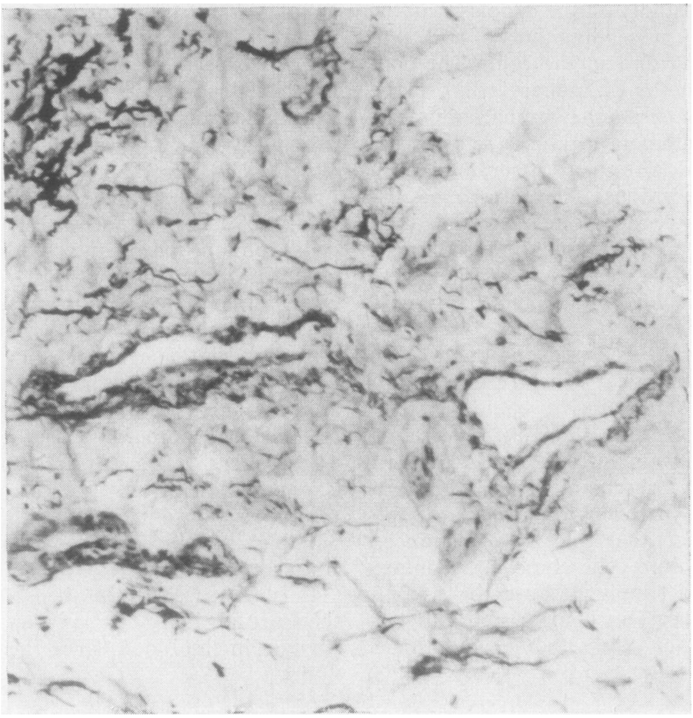

FIG. 9. *Level 15. The glomus terminates in small, thin-walled veins which drain away in the adventitia of the pulmonary trunk (H. and E.).*

Heymans, Bouckaert, and Dautrebande (1930) and Comroe (1939). From all the available evidence it seems highly likely, therefore, that the glomic tissue on the pulmonary trunk subserves the same chemoreceptor function.

The crucial point, however, is what sample of blood the pulmonary glomic tissue monitors. Krahl (1962) believes that this glomus receives its blood supply from the pulmonary trunk. His observation is supported by the physiological findings of Duke and Green (1964), who describe bursts of afferent vagal impulses following injection of cyanide into the pulmonary trunk. On the other hand, Becker (1966) considers that the blood supply to the pulmonary glomic tissue is from the intertruncal artery, which is a branch of the left coronary artery. This alternative view is supported by the work of Comroe (1962), who stated that he had been forced to conclude that there was no chemoreceptor attached to the pulmonary arteries which was responsive to low oxygen tension. He had never been able to produce immediate respiratory stimulation by injection into the pulmonary arteries of cyanide, which is a known stimulator of carotid body chemoreceptor tissue, presumably by the creation of local tissue anoxia.

Comroe believes that to prove conclusively the existence of a glomus pulmonale which is quite distinct from the aortic body it is essential to demonstrate both glomera in the same subject. One should be able to demonstrate a pulmonary glomus with a blood supply from the pulmonary trunk, and an aortic glomus with a blood supply from the aorta.

In the present case we were concerned solely with the microanatomy of the glomic tissue associated with the pulmonary trunk, and made no attempt to demonstrate the source of the parent artery. The vascular supply of this glomus is, however, now under investigation.

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