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ARCHITECTURE OF PULMONARY INTERSTITIAL MICROVESSELS IN BACTRIAN CAMEL (*Camelus bactrianus*)

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ABSTRACT

The microvasculature of the lung in the bactrian camel (*Camelus bactrianus*) was studied with the replica scanning electron microscopic method. The results showed that the microvessels of the lung were branched, coursed regularly and densely arranged. The corrosion casts revealed a complex three dimensional network completely. Numerous anastomoses on different orders were found between the pulmonary interstitial and pulmonary microvessels.

Key words: Bactrian camel, pulmonary interstital microvessels architecture, scanning electron microscopy (SEM)

For several decades ago, many researchers have studied the microvessles of the lungs in many species by vivid microstructure observation, radioautodevelopment, transmission electron microscopy and cast scanning electron microscopy. Irwin *et al* (1954) observed the branching of the pulmonary microvessels in rat and guinea pig by using the microscope. Weibel and Gomez (1962) studied the morphology of the lung capillaries of the human by scanning electron microscopy. The microvessels of the lungs were studied in rats (Hijiya and Okada, 1978; Shen *et al*, 1988) in cats (Hou *et al*, 1981, 1983) in human (Zhen *et al*, 1990) and in human and monkey (Rui *et al*, 1993) by cast scanning electron microscopy and obtained solid images of the relationships between the alveolus and its surrounding capillaries. Smith and Campbell (1976); Smith and Rapson (1977) compared microvessels of the hoptoad lung with those of other animals. West *et al* (1977), Brackenbury and Akester (1978); Fujii and Okamoto (1981) and Liu and Sun (1994) observed the microvasculature of the lungs of the birds by SEM. Yu (1997a, b, 1998a, b) studied the arrangement of pulmonary microvessels of some reptiles. This study was aimed to describe the microvessels of the lung of the bactrian camel and to probe into adaptability of the camel to draught and arid environment.

Materials and Methods

The whole lungs of six adult and healthy bactrian camel (4 castrated and 2 female) were collected from the slaughter house of the Right Alasan Banner Food Company in the Inner Mongolia Autonomous Region, China, after slaughter, the lungs were immediately injected with 10% ABS solution in butanone (ternary copolymer of arylonitrile, butadiene and styrol) (Zhang *et al*, 1981) completely through the pulmonary artery. The specimens were then put in flow water for 24 - 72 hours so that the ABS hardened completely.

Small pieces of the injected specimens were cut from different lung lobes, using a sharp blade after being iced. The specimens were put in 10% hydrochloric acid at room temperature for 1 - 2 weeks and then washed slowly in flowing water in net box. After washing out all the residue, the casts were selected, dried and sputter-coated with gold-palladium and examined in a Hitach S520 Stereoscan scanning electron microscope.

Results

The present results showed that there is no evident difference in the pattern of vascularisation among camel lungs or lung lobes. The SEM observations revealed a dense arrangement and

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regular branching and course of the pulmonary microvasculature.

The lung interstitial microvascularisation

The connective tissue was very plenty in the camel lung. The interlobular septa is characterised by much more adipose tissue and rich network of microvessels. The letter microvessels vary in diameter betwen 7 - 38 μm. They were seen as flat bursae, running along the interlobular septum giving off many rambling twigs along its course. The interstitial microvessel usually accompany a subpleural arteriole forming an H - shape structure and join its stem vessel again. The microvessels give off, also branches to supply the surface of the subpleural microvessel network forming together a very loose interstitial microvessel network (Fig 1).

Communication between interstitial and pulmonary microvessels

There were wide communication between the interstitial and pulmonary microvessels in the camel lung. The interstitial microvessels directly unite not only with the subpleural microvessels (Fig 2) and subpleural precapillary arterioles (Fig 3) but also with the terminal arteriole (Fig 4). At the junction of interstitial and pulmonary microvessels, the circular deep impressions formed by smooth muscle cells of orifice of the alveolar duct were clearly observed.

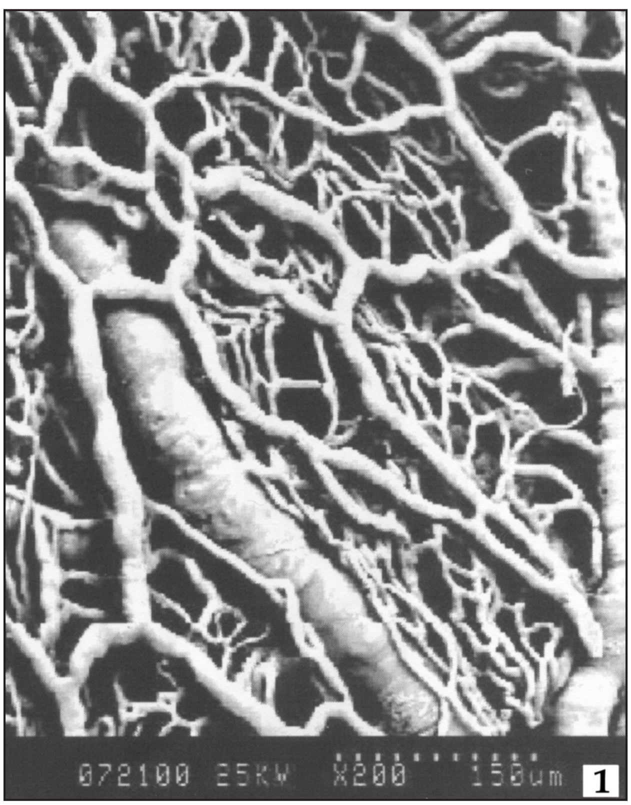

Fig 1. Photograph of a pulmonary interstitial microvessels cast showing the pulmonary interstitial microvessels (*) communicated with each other and from very loose microvessel network on that surface of the subpleural microvessel network (↑).

Discussion

Anastomosing between interstitial and pulmonary microvessels

The scientsts proved that the bronchial artery, after entering the lung in mammal, gave rise to branches to supply the mediastinum pleura, pericardium, lymph node, pulmonary pleura and subpleural connective tissues besides the wall of each grades of bronchi, pulmonary artery and vein (Miller, 1947; Verloop, 1948; Yao and Zhou, 1985). Therefore, the lung interstitial microvessels were actually branches of the bronchial artery beneath the pulmnary pleura and in the interlobular septum. The present study affirmed the presence of communicating branches between the vessels of the bronchial and pulmonary circulations. But on the position where communication took place and the level of the communication vessel, there was still no certain conclusion. Lapp (1951) thought that bronchial artery supplied the bronchi as far as the alveolar duct where it is separated into the capillary network and communicated with the alveolar capillary. But Verloop (1948) and Tobin (1952) thought that the supply of the bronchial artery was only as far as the respiratory bronchiole where communication occurred with the pulmonary artery. Pump (1963, 1972) observed that the bronchial artery gave rise to the bronchial pulmonary branch before the terminal bronchiole appeared and supplied the alveolar wall where it communicated with the terminal branches of the pulmonary artery forming the capillary network. Observing the communication between the bronchial and pulmonary arteries, Zhang (1958) found that the bronchial and pulmonary arteries together companied the bronchial tree and supplied the alveolar wall. Comparing the pulmonary microvessels in several mammals. Richhand *et al* (1961) mentioned that the supply of the bronchial artery in human was same as in horse, except that it supplied the alveoli along the terminal bronchiole and also along the interlobular and pulmonary pleura. Yao and Zhou (1985) indicated that the end-end and end-branch communications were observed among the bronchial and pulmonary arteries and vein

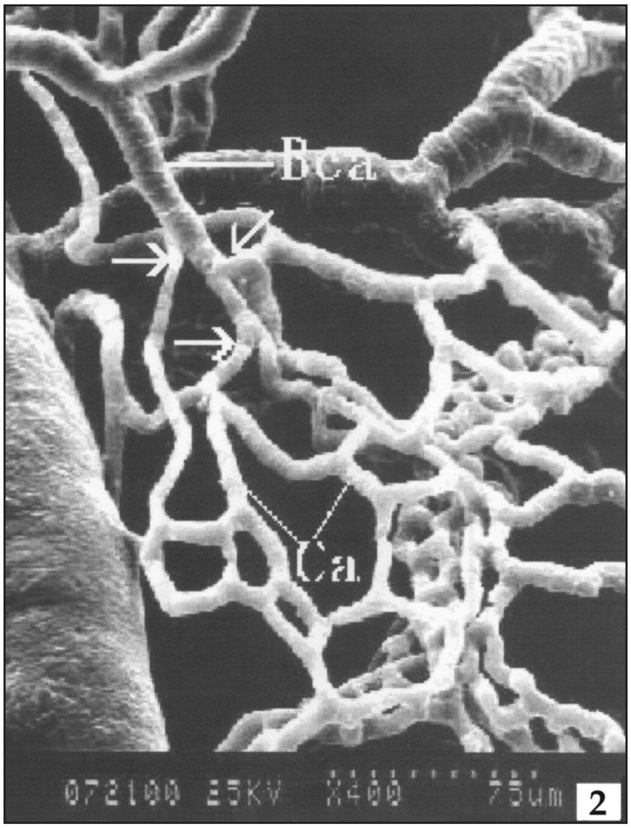

Fig 2. Photograph of a pulmonary interstitial microvessels cast showing anastomoses between the pulmonary interstitial capillary (**Bca**) and the subpleural capillary (**Ca**). The arrows (↑) showed the junction of the pulmonary interstitial capillary (**Bca**) with the subpleural capillary (**Ca**).

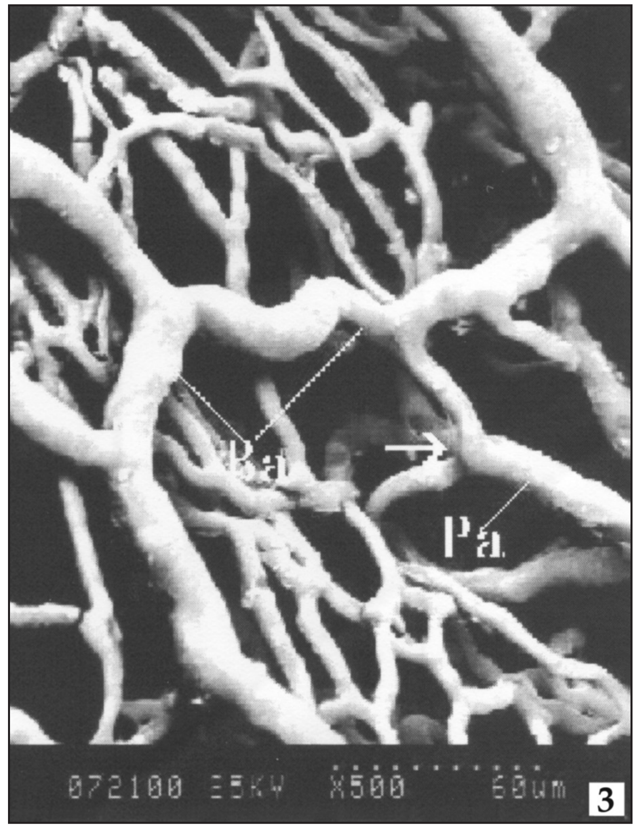

Fig 3. Photograph of a pulmonary interstitial microvessels cast showing anastomosing of the pulmonary interstitial microvessel with the subpleural microvessel. The arrow (↑) showed the junction of the pulmonary interstitial microvessel (**Ba**) with the subpleural precapillary arteriole (**Pa**).

and before the capillary in the pulmonary pleura of human. In addition, Zhen *et al* (1990) described broad communications among the pulmonary interstitial and alveolar capillaries in the cast of the human pulmonary microvessel. The present study found that broad and different level communications were present among the pulmonary interstitial and subpleural microvessels in the bactrian camel. The interstitial microvessels communicated not only with the subpleural capillaries but also with precapillary arterioles. The communicating branches present between the interstitial microvessels and terminal arterioles. By studying the communicating vessels Lapp (1951), Verloop (1948) and Hayek (1953) found that there was a muscular tissue in the vessels, which suggest an active regulating function. The circular impressions on the casts of the junctions of the communicating branches or the microvessels became slender in the Zhen *et al* (1990) observation, which also suggested that this kind of communication had controllability. On the casts of the junctions of the pulmonary interstitial vessels and pulmonary artery in the bactrian camel, the authors also found similar circular impressions formed by the smooth muscle cells which showed that the communicating branch between the pulmonary microcirclation and bronchial circulation had also active regulating ability.

Although part of the communications, between the subpleural and interstitial vessel, were only observed, from universality of communication, it was realised that there were multi-regulating mechanism between the body and pulmonary circulations in the bactrian camel, which was uniform with the very strong endurance of the camel to rigorous environment.

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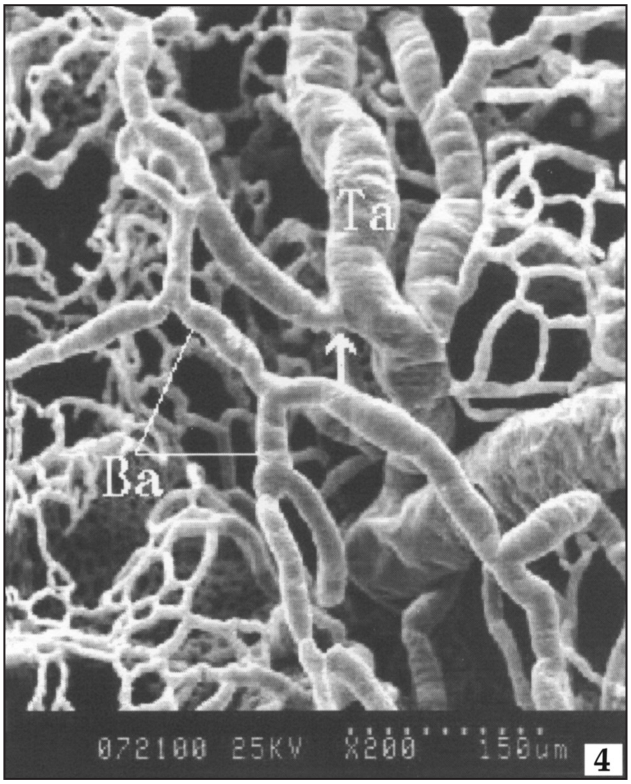

Fig 4. Photograph of a pulmonary interstitial microvessels cast showing anastomosing of the pulmonary interstitial microvessel (**Ba**) with the subpleural terminal arteriole (**Ta**). The arrow (↑) showed the junction of the pulmonary interstitial microvessel (**Ba**) with the subpleural terminal arteriole (**Ta**).

References

Brackenbury JH and Akester AR (1978). Respiratory function in birds, adutl and embryonic. Piiper J (Ed.), New York, Springer-Verlag. pp 125.

Fujii S and Okamoto T (1981). Microarchitecture of air capillaries and blood capillaries in the respiratory area of the hen's lung examined by scanning electron microscopy. Japanese Journal of Veterinary Science 47:51.

Hayek HV (1953). Die Menschliche Lunge. Springer, Berlin, Goettingen, Heidelberg.

Hijiya K and Okada Y (1978). Scanning electron microscope study of the cast of the pulmonary capillary vessels in rats. Journal of Electron Microscopy 27:49.

Hou G, Wei B and Zhang C (1981). Observing of pulmonary capillary and alveolar casts by SEM. Acta Anatomica Sinica 12(4):390.

Hou G, Wei B and Rui L (1983). Observing of human pulmonary capillary and alveolar casts by SEM. Acta Anatomica Sinica 14(2):113.

Irwin JW, Burrage WS, Aimar CE and Chesnut RW Jr (1954). Microscopical observations of the pulmonary arterioles, capillaries and venules of living guinea pigs and rabbits. Anat. Rec. 119:391.

Kendall MW and Eissmann E (1980). Scanning electron microscopic examination of human pulmonary capillaries using a latex replication method. Anat. Rec. 196:275.

Lapp H (1951). Ueber die sperrarterien der lunge und die anastomosen zwischen A. bronchialis undA. pulmonalis, ber ihre bedeutung, insbesondere fur die entstehung des hamorrhagischen infarktes. Frankfurt Z. Path 62:537.

Liu D and Sun J (1994). Observing of pulmonary capillary in pigeon by SEM. Chinese Journal of Zoology 29(5): 21-22.

Miller WS (1947). The Lung. Thomas, Springfield, Illinois, 2nd Ed.

Pump KK (1963). The bronchial arteries and their anatomoses in the human lung. Dis. Chest. 43:245.

Pump KK (1972). Distribution of bronchial arteries in the human lung. Chest. 62:447.

Richhand F, Mclaughlin, Tyler WS and Canada RO (1961). A study of the subgross pulmonary anatomy in various mammals. American Journal of Anatomy 108:149.

Rui L, Yuan G and Wei B (1993). Three dimensional architecture of microvessel in human and monkey. (Beijing: Science Press). pp 69-73.

Shen H, Zhang Y and Qihong (1988). Observing of rat pulmonary capillary and alveolar casts by SEM. Acta of the Second Surgeon University 9(6):536.

Smith DG and Campbell G (1976). The anatomy of the pulmonary vascular bed in the toad *Bufo marinus*. Cell Tissue Research 165(2):199-213.

Smith DG and Rapson L (1977). Differences in pulmonary microvascular anatomy between *Bufo marinus* and *Xenopus laevis*. Cell Tissue Research 178(1):1-15.

Tobin CE (1952). The bronchial arteries and their connection with other vessels in the human lung. Surg. Gynaec. Obstet. 95:741.

Verloop MC (1948). The arteries bronchiales and their anastomoses with the arteria pulmonalis in the human lung: A microanatomical study. Acta Anat. (Basel) 5: 171.

Weibel ER and Gomez DM (1962). Architecture of the human lung. Science 137:577.

West NH, Bamford OS and Jones DR (1977). A scanning electron microscope study of the microvasculature of the avian lung. Cell Tissue Research 176(4):53-64.

Yao Z and Zhou J (1985). Bronchial artery and its anastomosing with pulmonary vessel in lung. Acta Anatomia 16(1): 15 - 19.

Yu S (1997a). Observing of microvessel cast in Rana temporaria chensinensis lung by SEM. Chinese Journal of Lanzhou University 33:280-282.

Yu S (1997b). Observing of pulmonary microvessel in Snake coluber spinalis by SEM. Acta Zoologica Sinica 43(2): 214.

Yu S (1998a). Observing of capillary and alveolar casts in mouse lung by SEM. Chinese Journal of Northwest Normal University 34(2):65-68.

Yu S (1998b). Observing of microvessel cast by SEM. Acta Zoologica Sinica 44(4):384-390.

Zhang Y (1958). Course, supply of bronchial artery and its anastomosing with pulmonary artery in lung. Acta Anatomica 3:245.

Zhang C, Wei B and Hou G (1981). Applying of method of ABS vessel cast by SEM in physics and biology studies. Chinese Journal of Physics 3(1):50.

Zhen B, Zhang Y and Zhang L (1990). Study on microvessel of adult human lung. Acta Anatomica Sinica 21(3): 233-238.