

PARTIAL OXYGEN PRESSURE AND TISSUE  
RESPIRATION IN PC-1 TUMORS DURING GROWTH

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The partial oxygen pressure and tissue respiration were measured in a transplanted PC-1 tumor and in the surrounding normal tissue for 3 days at 24-h intervals. The values obtained in the muscle fluctuated only a little. The partial oxygen pressure in the tumor falls during growth while its tissue respiration shows a tendency to decrease in the last stages of the investigation.

Experiments have shown [5, 7, 12] that the partial oxygen pressure ( $pO_2$ ) in solid tumors is several times lower than in normal tissues. In tumors there are certain zones with a low concentration or even total absence of oxygen. However, these observations are based on the results of a single determination of  $pO_2$  in tumors. There are isolated reports of changes in  $pO_2$  in an ascites tumor in the early stages after transplantation [6, 11]. During growth of the tumor the  $pO_2$  level in the ascites fluid falls sharply, sometimes to zero. As regards solid tumors, no reports of such investigations of the  $pO_2$  over a period of time could be found in the accessible literature.

The object of the investigation described below was to determine  $pO_2$  in a tumor and at the same time to study the level of oxygen assimilation for 3 days at 12-h intervals.

## EXPERIMENTAL METHOD

Experiments were carried out on 112 noninbred albino rats weighing 110-130 g with a PC-1 tumor transplanted into the hind limb. The values of  $pO_2$  in the center of the tumor, at its periphery (at five or six points), and in the surrounding normal tissue (gastrocnemius muscle) were measured amperometrically [3, 4]. The tissue respiration was measured by Warburg's gasometric method [9]. The results of the measurements were expressed in microliters oxygen absorbed in 20 min per 100 mg dry weight of tissue.

The volume of the tumor was measured by Schreck's method [15] at 12-h intervals for 3 days.

The numerical results were subjected to statistical analysis.

## EXPERIMENTAL RESULTS

The experiments of series I showed that the original value of  $pO_2$  in the peripheral zone of the tumor was higher than in the central zone ( $5.5 \pm 0.7$  compared with  $1.5 \pm 0.32$  mm Hg). In different parts of the same tumor,  $pO_2$  varied from 0 to 16 mm Hg.

In the course of 3 days the tumor doubled in volume. The degree of oxygen saturation in it fell both at the periphery and in the center. At the last time of measurement (the 18th day after transplantation)  $pO_2$  was  $2.5 \pm 0.20$  and  $1.0 \pm 0.29$  mm Hg, respectively. It must also be noted that zones with a low level of  $pO_2$  were found more often at this time. Whereas during the first day of investigation on the average only one of nine to 10 zones measured had a low oxygen concentration, on the last day of measurement there were two or three or even more such zones.

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In normal tissue  $pO_2$  was 5-6 times higher than in the tumor tissue, and at the times studied there were only slight diurnal fluctuations.

The experiments of series II showed small diurnal fluctuations in the respiration of the normal tissue. The intensity of oxygen uptake in the tumor was not less than in the muscle. Whereas the oxygen uptake ( $QO_2$ ) in the muscle was  $38 \pm 2.22 \mu l$ , in the tumor it was  $35.2 \pm 3.21 \mu l$  at the periphery and  $33.8 \pm 2.6 \mu l$  at the center. These results agree with data in the literature [2, 8, 10] that the potential respiratory capacity of the cancer cells is not lower than that of normal cells.

The study of  $QO_2$  of the tumor during its growth showed that the tissue respiration in the early periods of the investigation (12-36 h) was within its original limits and a tendency to decrease was observed only after 60 and 72 h.

During growth of a tumor the degree of its oxygen uptake gradually rises to a certain limit, after which it begins to fall slowly [1, 13, 14].

In the present experiments the oxygen absorption in the PC-1 tumor may have reached its maximum by the 16th-17th day after transplantation and thereafter fallen gradually with growth of the tumor.

Comparison of the results of measurement of  $pO_2$  in the tumor with the intensity of its tissue respiration thus shows that the latter is not the limiting factor of the fall in  $pO_2$  in the tumor during its growth. The cause of the decrease in  $pO_2$  in the tumor in these experiments could therefore be disturbances of the mechanisms of oxygen transport.

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