CYTOENZYMOLOGY OF SUCCINODEHYDROGENASE IN CELLS OF THE BROWN-PEARCE TUMOR

(UDC 616.006.6-092.4/9-07:612.015.184)

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Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 57, No. 5,
pp. 80-82, May, 1964
Original article submitted May 25, 1963

Succinodehydrogenase (SDH) is an enzyme playing an important role in the oxidative processes of normal and malignant cells. Information on the state of SDH in neoplastic tissue is contradictory. A number of authors [5, 7, 13] consider that the activity of SDH in tumors is higher than in normal tissue. Other authors [8, 12, 14] demonstrated that SDH is absent in experimental and spontaneously generated malignant tumors.

We carried out a histochemical investigation of SDH in a primary Brown-Pearce tumor of rabbits and in metastases of various organs which developed from this tumor in order to establish the relation between the activity of SDH in malignant cells and the growth of a primary Brown-Pearce tumor and its metastases.

METHOD

The material for the investigation was a primary tumor, as well as metastases in the mesentery, kidney, and liver. For investigation of the primary tumor, the animals were killed on the 7th and 14th day after inoculation. The metastases were taken from the animals on the 21st and 35th day after inoculation of the primary tumor. The SDH was elicited by Seligman and Rutenburg's method as modified by Hirono [6]. We used the salt of tetrazolium-nitro-ST.

RESULTS

The cells of the growing zone of the primary tumor, as well as the cells from the zone of growth of various metastases of different age were characterized by a high activity of SDH (Fig. 1). The sites of activity of SDH were elicited in the mitochondria as small, and sometimes larger, dark-blue deposits of formazan, which formed as the result of the reduction of nitro-ST (see Fig. 1). SDH was not histochemically detected in the nucleus and nucleoli. The number of formazan granules in various cancer cells was different. In certain cells there were many granules, and in others were few.

Formazan granules were larger in the viable cells of the more mature primary tumor and in cells of metastases

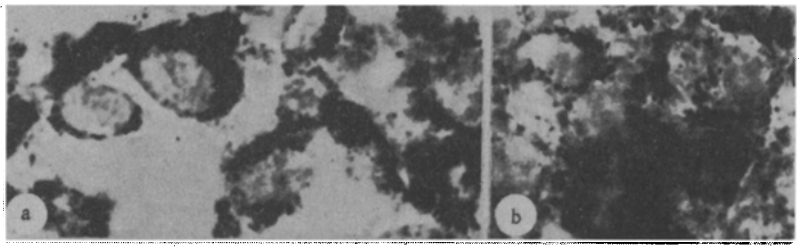

Fig. 1. SDH in cells of primary tumor aged 1 week (a) and 2 weeks (b).

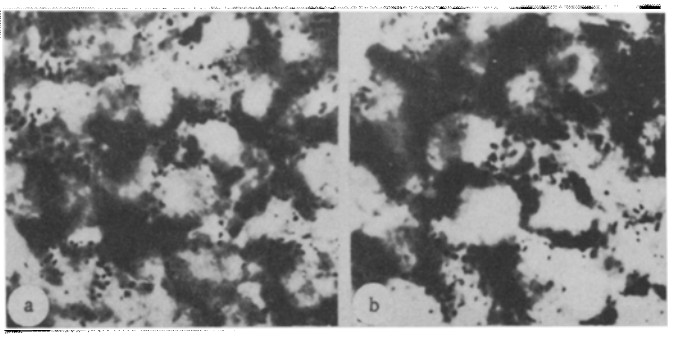

Fig. 2. SDH in cells of kidney metastases of 3 weeks development (a) and in cells of liver metastases of 3 weeks development (b).

that developed for a longer period. This is possibly due to a disturbance of the physical and functional state of the mitochondria. This assumption confirms the data of a number of investigators [1-4, 9-11] who demonstrated that nitro-ST is an indicator of the physical and functional state of mitochondria. In degenerating cells the number of formazan granules markedly drops, and in the central zone of necrosis filled with dead cells there is no reaction. This indicates a different level of the oxidative processes in actively functioning and degenerating cancer cells.

The activity of SDH varies depending on the age of the tumor. In cells of a young primary tumor (1 week development) and in cells of various metastases that developed in 3 weeks, the activity of the enzyme is less than in cells of a more mature primary tumor (2 weeks development) and in cells of more mature metastases (5 weeks development) (Fig. 1, 2, and 3). This apparently reflects the change in the respiratory rate in these cells.

The activity of SDH in malignant cells of the growth zone of various metastases is dissimilar. For example, SDH has a higher activity in the cells of mesenteric metastases, a lower activity in the cells of kidney metastases; the lowest activity was observed in cancer cells of liver metastases (see Fig. 2 and 3). This regularity is apparently associated to some degree with the conditions of growth and development of the metastasizing cells.

SUMMARY

A study was made of succinodehydrogenase by Selgiman and Rutenburg method, modified by Hirono, with a tetrazolium salt—nitro-ST in the cells of primary Brown-Pearce tumor and its metastases into the liver, mesentery and kidney at various periods of the primary tumor and metastases development.

High SDH activity characterized the cells of the growing area in the primary tumor, as well as the cells of the growth zone in various metastases of different age. Sites of SDH activity were found to appear in the mitochondria. The number of formazan granules differed in various cancer cells. Formazan granules were larger in viable cells of

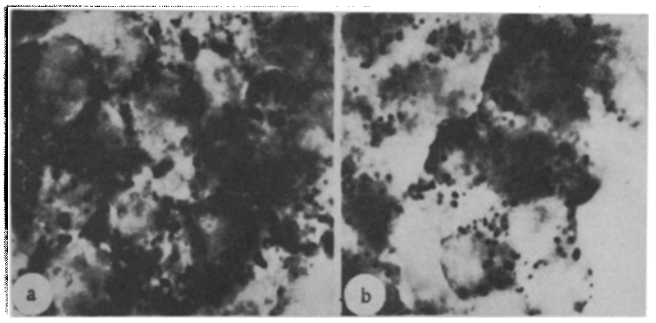

Fig. 3. SDH in cells of kidney metastases of 5 weeks development (a) and in cells of liver metastases of 5 weeks development (b). Magnification 1320 ×.

a more mature primary tumor, as well as in the cells of metastases developing for a more prolonged period.

In the cells of a young (7-day) primary tumor and of various 3 week metastases, the enzyme activity was less marked than in the cells of a more mature primary tumor (2 week) or of more mature metastases (5 week). SDH activity differed in the malignant cells of various metastases. Thus, SDH possessed a higher activity in the cells of mesentery metastases, lesser—in the cells of kidneys metastases, and the least—in the cancer cells of liver metastases.

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