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Possible Factor Produced During Muscular Contraction which Influences the Passage of Glucose.* (27656)

R. R-CANDELA AND J. L. R-CANDELA
Instituto G. Marañón, Madrid, Spain

Muscular work increases glucose utilization by muscle possibly by a mechanism which regulates the permeability to glucose. Sacks and Smith(1) have shown that there is a specific steric requirement for the non-metabolized sugar to penetrate the cell membrane during muscular contraction. The effects of insulin and muscular work are additive. Goldstein and co-workers(2,3) have suggested that this increased permeability for glucose could be due to a humoral effect.

Our experiments have been performed to determine if a buffer solution which has been surrounding a contracting uterine muscle, affects the passage of glucose to diaphragm, adipose tissue of the epididymis, kidney and brain.

Materials and methods. Buffer solutions surrounding uteri in periodic contraction and permanent relaxation were obtained as previously described(4). The effect of buffer (C-B) used for contracting tissue on glucose uptake was measured by diluting it in Warburg flasks with Krebs-Henseleit buffer. When diaphragm was used, 1 ml of C-B was mixed with 1 ml of Krebs-Henseleit, when kidney, epididymal fat or brain were employed, 0.1 ml of C-B was mixed with 1.9 ml of Krebs-Henseleit. Pyruvate was also added to the latter when brain tissue was incubated. Equal volumes of "relaxation buffer" (R-B) were used for the controls. Incubation conditions were as follows: the final volume was 2 ml, glucose concentration was 3 mg/ml, the wet weights of brain slices were 50-75 mg, those of kidney, diaphragm and epididymal fat 150-200 mg. Incubation lasted 1½ hours for muscle and kidney, 1 hour for brain and 4 hours for epididymal fat and was carried out at 37°C with 70-80 cycles of 2 cm amplitude/min in air, except for brain tissues. In the latter case a 95% O_2-5% CO_2 mixture was used. Glucose was determined by the Somogyi-Nelson method and glucose uptake is expressed as mg of glucose disappearing from the medium/100 mg tissue (wet weight). Oxygen consumption is given as μl/hr/100 mg tissue (wet weight). Statistical analysis of results was performed using the paired observations method (Diaphragm, adipose tissue and kidney) or "t" method of Student (5), for brain.

Results and discussion. The buffer previously used for incubation of contracting uterine muscle increases the permeability of diaphragm, epididymal fat and kidney to glucose (Table I). The sensitivity of these tissues to the supposedly humoral factor varies. Adipose and renal tissue are 10 times more sensitive than the striated muscular tissue (diaphragm). Glucose uptake of the brain does not seem to be influenced, though respiration increases significantly.

Our results support the hypothesis that a

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TABLE I

Tissue*	Mean glucose uptake (mg/100 mg of tissue) C–B	Control, R–B	P
Diaphragm (14)	.446	.307(±.027)†	P = .01
Adipose (15)	.293	.184(±.025)	P = .01
Kidney (18)	.757	.408(±.075)	P = .01
Brain (11)	.677(±.070)†	.628(±.073)	P > .05

	Mean respiration (μl O_2/100 mg tissue/hr) C–B	Control, R–B	
Brain (11)	207.7(±7.90)	162.2(±7.10)	P < .01

* Figures in parentheses are number of experiments.

† Standard error of the mean.

humoral factor is produced during muscular contraction which enhances the entry of glucose into tissues. We are now investigating the nature of this factor and its possible physiological role.

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Development of Hyaline Membranes and Atelectases in Experimental Chronic Respiratory Acidosis.* (27657)

H. NIEMOELLER AND K. E. SCHAEFER

Department of Pathology, Yale University School of Medicine, New Haven, and U. S. N. Medical Research Laboratory, New London, Conn.

Carbon dioxide retention has been considered a primary factor in the development of pulmonary hyaline membranes in the asphyctic newborn(1). Atelectases associated with hyaline membranes is a frequent cause of death in the newborn(2). Exposure of guinea pigs to 14-17% CO_2 in 21% O_2 for 8-22 hours was found to result in hyaline membrane formation while ammonium chloride acidosis (3-24 days) failed to produce such effects(3). On this basis it was concluded that hyaline membrane formation is caused specifically by CO_2 rather than by acidosis(3). However, during our studies of chronic CO_2 toxicity it was observed that incidence of hyaline membrane formation progressively decreased in guinea pigs during prolonged exposure to CO_2 after compensation of the respiratory acidosis. This supports the concept of non-specific acidosis.

Material and methods. Male guinea pigs (400-600 g) of the Hartley strain and male albino rats from the colony of the Harvard Biological Laboratories (age 75-120 days) were exposed to various CO_2 concentrations for different periods. Animals in any particular group were of the same age. They were sacrificed after exposure to CO_2 and after recovery periods of various lengths.

Anaerobic blood samples were taken through heart punctures. pH was measured at 37°C by a Model G, Beckman pH meter. Whole blood CO_2 content was determined with the Van Slyke apparatus and CO_2 tension was calculated using the nomogram of Van Slyke and Sendroy(4).

Exposure times were divided into 2 periods corresponding to the phases of uncompensated and compensated respiratory acidosis. The former was found to last 23-28 days under 1.5% CO_2, 4-5 days under 3% CO_2, and 2 days under 15% CO_2(5). Furthermore, a third period of extended exposure was included. Recovery periods of one day and 2 weeks were selected. The histological data presented show incidence of pulmonary path-

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