Cerebro-Spinal Fluid Lactate Concentration in Neurologically Normal and Abnormal Children

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The brain uses glucose as it is exogenous substance and is totally dependent upon aerobic metabolism for its continued existence. It is logical to find an alteration of lactate concentration which is the end product of glucose in neurologically abnormal individuals.

The measurements of cerebral arterio-venous differences in the concentration of metabolites have frequently been done in an effort to analyze cerebral metabolism.[1 2] Because of the presence of the blood brain barrier, the blood values may not reflect the actual metabolic changes of the brain.[3-5] The concentration of metabolites in the cerebrospinal fluid (CSF) may, however, provide more information in terms of brain metabolism.[6 7]

In the present investigation the lactate concentration in CSF has been studied in both normal and various groups of abnormal children. A significant difference was found between the mean value among the various groups and that of normal children. A statistical analysis of the data constitutes the basis for the present report.

Material and Methods

Clinical material : The studies were performed on 110 patients between the ages of 1 month to 10 years. The patients were divided into

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seven groups according to their final diagnosis which was reached after extensive clinical and laboratory investigations.

Group I : 25 patients with brain damage due to prenatal, natal or postnatal trauma.

Group II : 19 patients with acute purulent or tuberculous meningitis.

Group III : 17 patients with viral CNS infection.

Group IV : 17 patients with primary or secondary CNS tumors.

Group V : 6 patients with cerebro-vascular accident.

Group VI : 6 patients with degenerative CNS disease.

Group VII : (Control group) 20 patients with normal neurological examination and laboratory findings.

Complete physical and neurological examinations, Hb, WBC, routine urine analysis and $FeCl_3$ tests were done on all patients.

Electroencephalography, pneumoencephalography, ventriculography, cerebral angiography, myelography, brain biopsy, bone marrow were done on some of the patients who required more extensive studies for a definite diagnosis.

CSF samples were drawn from patients by lumbar puncture. Ventriculopuncture was done on only 6 patients with increased intracranial pressure due to brain tumor. For lactate and lactic dehydrogenase (LDH) determinations, the samples were stored in closed tubes in deep-freeze for not longer than four weeks. The lactate was measured colorimetrically according to the method described by Barker and Summerson.[8] Duplicate samples were used for each determination. Lactic dehydrogenase (LDH) was determined by isoenzymes U. V. method.[9] The protein and sugar contents of CSF were also measured from the same samples.

Results

The data obtained from the various groups is given in Tables 1 and 2 and Figures 1 and 2.

In the 20 control patients the mean lactate value in the CSF was 1.55±0.035 mEq/L.

In the first group which includes children with brain damage, the mean value was 1.14±0.036 mEq/L ($P<0.05$).

	GROUPS	NUMBER OF PATIENTS n	MEAN VALUES $\bar{x}$	STANDARD ERROR $\pm s\bar{x}$	STANDARD DEVIATION $\pm s$
LACTATE mEq/L	CONTROL	20	1.550	0.035	0.16
	GROUP I	25	1.140	0.036	0.18
	II	19	6.700	0.958	41.97
	III	17	2.288	0.019	0.82
	IV	17	2.217	0.017	0.72
	V	6	3.366	0.728	1.78
	VI	6	3.666	0.458	1.12

Table I Cerebro – spinal fluid lactate values

	GROUP		D(x)	SD	t	RESULT
LACTATE mEq/L	"	G_1	0,410	0,05	8,200	P< %5
	"	G_2	5,150	0,96	5,375	P< %5
	"	G_3	0,838	0,04	20,950	P< %5
	"	G_4	0,667	0,04	17,552	P< %5
	"	G_5	1,816	0,73	2,491	P< %5
	"	G_6	2,116	0,46	4,610	P< %5

Table II statistical evaluation of the cerebro-spinal fluid lactate values between controls and patients

(x) Differences between the averages

In the second group the mean lactate value 6.7 ±0.958 mEq/L was four times higher than in the control group ($P<0.05$).

In the third group the mean value of 2.38±0.019 mEq/L was also statistically significant. The interesting findings in this group of samples were the differences between the initial and the later stage of the disease. In this group, 3 patients with the diagnosis of subacute inclusion body encephalitis, of which 2 were confirmed by brain biopsy, showep

Mean values

	Lactate mEq/l
Control	:1,550
G_1	:1,140
G_2	:6,700
G_3	:2,388
G_4	:2,217
G_5	:3,366
G_6	:3,666

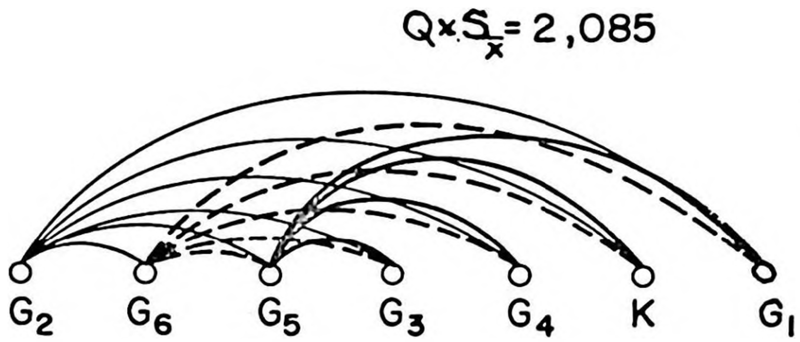

Fig I. statistical significance of the cerebro-spinal lactate values among the studied groups

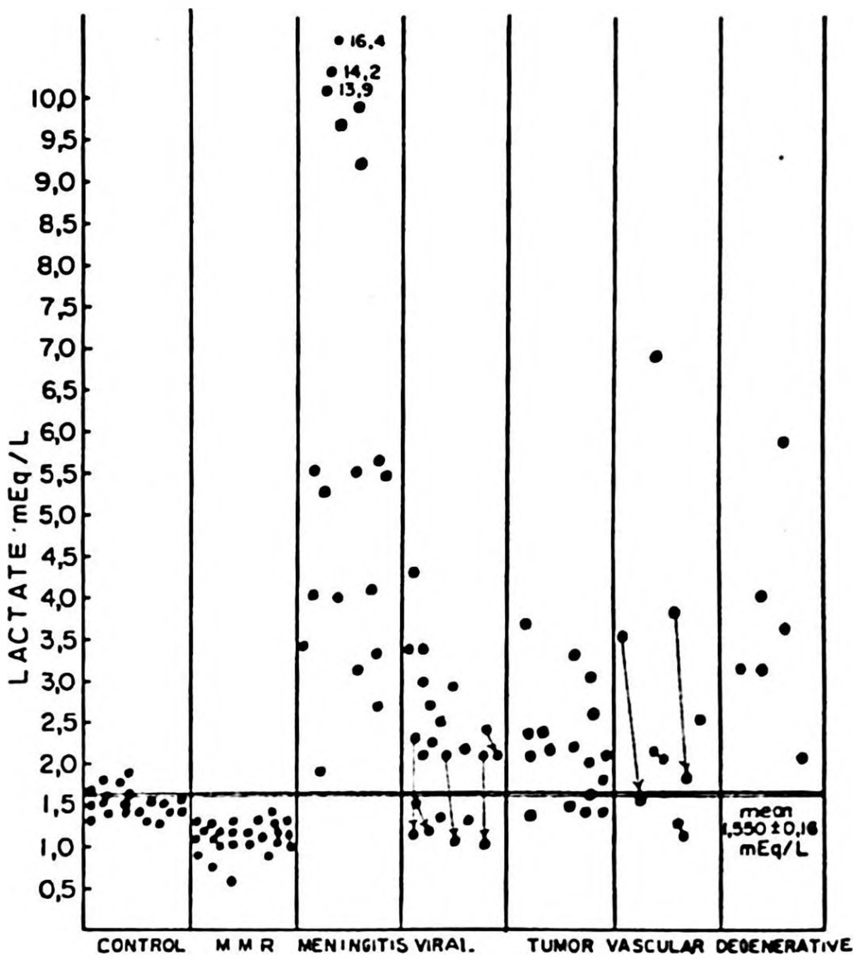

Fig 2 Cerebro - spinal fluid lactate values

• Each dots presents one sample

lactate values of 2.25-2.4-2.1 mEq/L initially. At the end of the first month, after the patients had deteriorated mentally, the lactate values decreased to a level of 1.2-1.24-1.0 mEq/L.

The results of lactate determinations in group IV were almost equal to those in group III, 2.217±0.017 mEq/L. The values were significantly higher than normal. These figures are significantly high compared with groups other than III.

The mean value of 3.366±0.782 mEq/L in samples taken from the patients in group V were twice as high as normal. Results from samples taken at one or two week intervals, later showed lower than average values which we can suppose to be due to the tissue damage.

The mean value of 3.66±0.48 mEq/L in group VI was higher than normal but not significant when compared with the other groups. This was probably due to the limited number of patients in the group.

Discussion

Oxidation of glucose by brain in vivo is apparently essential for its functional activities. In aerobic states, glucose is oxidized to CO_2 and H_2O, but under oxygen deprivation, glucose is converted to L-Lactic acid. The lactate level in CSF increases in patients with anaerobiosis,[10] tumors, bleeding in the tissue,[11-13] and anaerobic bacterias, E. coli being prevalent.

Brain lactate which is the last product of glucose was demonstrated by numerous investigators.[14-17] The lactate level also differs in normal and pathological conditions[12] as was shown in brain edema.[18]

Measurements of cerebral arterio-venous differences or pyruvate/lactate ratio are found to be unsatisfactory.[7] Inconformity of brain lactate levels and cerebral arterio-venous differences could be explained by the presence of the blood brain barrier (BBB). BBB has different diffusion rate for each metabolite. Gurdjian et al [19] found that in experimentally induced convulsion, lactic acid in the brain increased without the blood levels changing significantly. The lactate ion penetrates the blood-brain barrier imperfectly so that cerebral venous lactate measurement might inadequately reflect altered cerebral metabolism.[20] [21] It was also shown that the blood and CSF levels were changed independently.[22] Lactate levels of the CSF may be better indicators of cerebral metabolic disfunction than the lactate concentration of either the arterial or the cerebral venous blood.[23] [24] In 14 control patients the mean lactate value of blood was found to be 0.97±0.13 mEq/L, in CSF 1.58±

0.03 mEq/L by Posner and Plum.[6] The lactate level which is close to the above figure, was found to be 1.55±0.035 mEq/L in CSF of 20 control children in the present investigation.

The low level of the lactate in the first group could be explained by the decreased metabolic rate of brain damaged children. The decreased rate of metabolism was previously only demonstrated by reduced O_2 consumption in a small group of brain damaged children.[2,5] Measurement of the O_2 consumption could not be used as a routine laboratory test because of technical difficulty.[1] The results in children suggest that CSF lactate level may be used as a laboratory test to confirm the diagnosis of brain damaged children.

The lactate level was found to be considerably high in in acute purulant meningitis. This finding is especially important in the diagnosis of the early and partially treated meningitis case.

Lactate values were found to decrease if there was a considerable amont of tissue damage demonstrated in subacute encephalitis and cerebro-vascular accidents.

The lactate levels were significantly higher in viral diseases and tumors.

The increased level of brain lactate was previously demonstrated in cerebro-vascular accidents.[2,6] In the present study the highest level was found to be reached initially and the lower level at the later stage. This can be explained by diffused tissue damage.

In the degenerative group we could not reach a definite conclusion because of the limited number of patients.

Summary

In this paper the importance of lactate values in CSF in the diagnosis of neurologically normal and abormal children has been studied from a total of 110 patients including a control group of 20. A statistically significant difference was found between the mean value among the various groups and that of normal children. The lactate values in CSF can be of significant value in the diagnosis of various types of brain damaged and neurological diseases in children.

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