EFFECT OF PYRIDOXINE DEFICIENCY ON MATURATION OF NEUROMOTOR COORDINATIONS

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Abstract: In the present study the effect of preweaning pyridoxine deficiency indicates that the body weight and brain weight of pyridoxine deficient rats were significantly lower when compared to the control rats. Onset and stabilisation of reflex reactions were also delayed in the pyridoxine deficient rats. Maturation of neuromotor coordination in the vitamin deficient group was significantly slow as compared to the control groups. This suggests that the importance of maternal pyridoxine supplementation cannot be overlooked in pregnant women especially after prolonged use of anovulatory steroids.

Key words: pyridoxine deficiency neuromotor coordinations

INTRODUCTION

Malnutrition in early life has an adverse effect on the growth of body and the brain. Impaired development of the brain may lead to abnormal behaviour (1). Attempt to study the adverse effect of pyridoxine deficiency in adult animals was made both for behavioural and electrophysiological parameters (2). In the present study, the effect of preweaning pyridoxine deficiency in rats on the physical growth of the body and brain and also on the development of reflex reactions and neuromotor coordinations have been investigated.

METHODS

Albino rats of Wistar strain were reared with 12h light and 12h darkness. Food was prepared from bengal gram flour with vitamin and mineral supplements (3) and was available ad libitum along with water. Rats were divided into control and experimental groups. Control pups were reared by the mothers fed with normal food containing all the minerals and vitamins in required quantity. Experimental pups were reared by the mothers fed with food deprived of pyridoxine, resulting in maternal prenatal pyridoxine deficiency. Mothers were fed with B6 deficient diet during pregnancy and lactation.

Body weight of rats from the two groups was recorded. Male rats (n = 20) taken from 3 litters of control rats and male rats (n = 20) taken from 3 litters of B6 deficient groups were chosen. To assess the growth of the brain, the wet weight of the brain at different stages of development was recorded. To assess the physical development of the body, three criteria selected were (i) the day of onset of unfolding of external ear and its completion, (ii) the day of onset of eruption of incisors and its completion and (iii) the day of onset of opening of eyes and its completion. The onset of eye opening occurs when there is a slit like opening of the eyelids exposing only a portion of the eye ball. This process is usually complete in a day when the eye is fully exposed.

The criteria to assess the development of reflex reactions and the neuromotor coordinations were (i) the day on which righting reflex starts and is completed, (ii) the day on which crawling starts and (iii) the day on which supported standing starts.
On the day of birth and each day thereafter, all pups from both the groups were tested for righting reflex (RR) by placing the pup on its back on a hard surface and measuring the time required to turn over with all paws flat. Ability to turn over in 2.5s or less was recorded as positive RR (4). Crawling was defined as positive if the pup advanced forward, (belly raised) rising on all limbs in coordinated paddling movement. The day on which the pups first stood with support was also noted for both the groups. For these observations 6 male rats from the control group and 6 male rats from pyridoxine deficient group were used. The values were expressed as mean ± S.D. The statistical evaluation of the results were carried out using students ‘t’ test.

RESULTS

The body weight of PD rats at all the ages studied was significantly lower when compared to that of control rats (P<0.01), and this difference increased with age (Fig.1). Whole brain weight (wet) of vitamin deprived rats is significantly lower when compared to the control group (Fig. 2.). The unfolding of external ear flaps in control and experimental rats starts at an average age of 3.3±1.3 and 4±1.4 days respectively (Table I) and is completed at 4±1.4 and 4.7±1.2 days in control and PD rats respectively (Table I). Eruption of incisors begins...
at an average age of 11.1±1.4 and 12.1±0.9 days and is completed at 12±1.4 and 13.2±1.2 days in control and experimental rats respectively (Table I). The opening of the eyes and its completion is also delayed in PD rats significantly.

As shown in Table II, righting reflex appears at 3.3±1.1 days and is perfect at 6.1±1.6 days in control rats but in PD rats it is significantly delayed to 4±1.4 and 8.6±1.1 days respectively. Similarly crawling phenomenon and the capacity of supported standing are delayed in PD rats significantly.

TABLE II: Development of reflex reactions and neuromotor coordinations in rat.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Day of</th>
<th>Control (n = 6)</th>
<th>Pyridoxine deficient (n = 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Righting Reflex</td>
<td>Onset</td>
<td>3±1.1</td>
<td>4±1.4*</td>
</tr>
<tr>
<td></td>
<td>Completion</td>
<td>6±1.6</td>
<td>8.6±1.1*</td>
</tr>
<tr>
<td>Crawling</td>
<td>Onset</td>
<td>5.5±1.1</td>
<td>6.5±1.2*</td>
</tr>
<tr>
<td>Standing</td>
<td>Supported Onset</td>
<td>11.6±1.1</td>
<td>16±0.7**</td>
</tr>
</tbody>
</table>

Values are mean ± S.D. *P < 0.01; **P < 0.001

DISCUSSION

The low body weight of PD pups is partly related to the depleted body fat deposits of pyridoxine deficient mothers (5), which may cause in them poor nursing ability (6) and poor suckling ability of the PD pups (7). The pups of pyridoxine deficient mothers gained weight more slowly than normal pups even when fed by non-deprived foster mothers (7). This suggests that the prenatal deprivation of pyridoxine, independently affects the growth.

A spurt in brain weight observed during the critical periods of growth namely 10 to 20 days of age is associated with the neuron growth and multiplication. The neuron multiplication rate in PD animals are far below the rate in control rats, and may partly account for the delayed maturation of reflex reactions and neuromotor coordinations.

The delay in milestones of physical development suggests the overall retarded physical growth of animals under pyridoxine deficient conditions. Moreover, the delay in the opening of eyes probably indicates an overall delay in the maturation of sensory perceptual mechanism in PD rats. Late appearance of reflex reaction and neuromotor coordinations in PD rats suggests that under PD, the neuromotor coordination is poor and slow in maturation. Under protein restriction during pre and postnatal periods there was a delay in the onset of similar skills (8) and exploratory score in openfield activity was significantly lower in PD rats (9).

Pyridoxine is involved in numerous metabolic pathways including the synthesis of several putative neurotransmitters, and it is perhaps more important in as far as the maturation of neuromotor coordinations and behaviour are concerned (2). The decrease in the production of GABA (γ-aminobutyric acid) in the brains of pyridoxine deficient animals has been recognised. The turnover ratio, rather than the concentration of the neurotransmitters in the brain is considered more important in behavioural regulation (2), but this aspect in relation to pyridoxine deficiency has not been fully investigated. It is observed that in human infants the important milestones of child’s development such as holding up the head, dentition, sitting, standing, walking etc. are delayed in a number of deficiencies including protein calorie deprivation. The adverse effect brought about by the pyridoxine deficiency on the development of CNS emphasises the importance of pyridoxine as a nutritional factor during pregnancy. Anovulatory steroids are known to increase the requirement of vitamin B6 (10) and women who use contraceptive pills for prolonged period of time may have a relative deficiency of pyridoxine (11). To ensure the normal development of the child, maternal pyridoxine supplementation during pregnancy and lactation is recommended. However, further rehabilitation studies are necessary to see whether the above mentioned effects are reversible or not.

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