Changes in the structural protein concentrations of neurones and glia cells in some centre of the hypothalamus at different periods of starvation and dehydration

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Abstract

This study was carried out to determine alterations in the structural protein concentrations of the neurones and glia cells in different centre of the hypothalamus. Hundred Wistar Albino rats were left for starvation and dehydration. And then, for the restoration of starvation and dehydration the rats were fed and given water *ad libitum.* The concentration of the structural proteins was determined under the interference microscope. Results showed that the concentration of the structural proteins increased significantly (P<0, 01) in the cytoplasm of the neurones in the lateral centre of the hypothalamus, at 3rd day of starvation. However, it decreased significantly (P<0,001) at 5th day of starvation. The concentrations of the structural proteins in the cytoplasm of the glia cells also increased significantly at 5th day of starvation. The structural protein concentrations in nuclei and cytoplasm of the neurones and glia cells in all the examined centres decreased significantly (P<0, 01) especially in neurones.

As a result, it might be postulated that there is a mechanism responsible for the regulation of food water intake in case of metabolic deficiency.

KEY WORDS: starvation, dehydration, dehydration, structural protein

Introduction

Nerves system in mammals plays an important role in the regulation of the physiological functions. The regulation mechanism of the nervous system is the most perfect one among the other physiological regulation mechanisms. The specific function of nerve system such as receiving, transmitting, impulses, stimulating nerve cells and giving response and saving and precessing data are related to the protein and protein originated substances. The changes occurring in the protein mechanism of the nerve system causes abnormalities in the psishic and acquired activities (Sharby, 1974; Chaffe 1978).

The studies related to acetylcholine esterase monoamine oxidase, neutral and acid peptid hydrolase, acid phosphatase enzymes and water soluble proteins in different parts of hypothalamus and cortex showed the relationship between the functions of these enzyme systems and the activity and flexibility of the receptor system of the neurons. Implementation of these functions depends on the availability of the easily restored and water soluble proteins (Kogan, 1985; Kotayer 1986).

Since these structural proteins are made of inert substances, they do not dissolve in water and they act in a passive defense function. This state is seen in wool ceratin, silk warm fibrion and salivation. The structural proteins found in cells and membranes and not soluble in water have higher functional

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properties. The permeability and metabolisms of the cells are related to properties of structural proteins particularly with the electrical loads of them (Askerov, 1991; Askerov, 1994). It was stated that 17% of the proteins in the cells are the enzymes, 33% water soluble proteins and 55% the structural proteins (Bhwon, 1988; Serpek, 1998).

The study was carried out to determine the concentration of structural proteins during the different period of starvation and dehydration and their restoration in the neuron and glia cells in different centre of hypothalamus.

Material and Method

The study individuals were consisted of 110 Wistar Albino rats in the same age (nearly 6 months). The animals were divided into 11 groups, each of which contained 10 rats. The control group was given bath food and water ad libitum.

The second group was left for 3 and the thirty groups for 5 days starvation. Then the group exposed to starvation for 5 days was fed for 15 days (IV.group). The V^{th} , VI^{th} and VII^{th} groups were left dehydration for 1,3 and 5 days respectively. Then, the animals exposed to dehydration for 5 days were given water in periods of 7 days ($VIII^{th}$ group), 15 days (IX^{th} group), 30 days (X^{th} group) and 45 days (XI^{th} group). The animals exposed starvation was given water and the animals exposed to dehydration were given food ad libitum. After the experimental period, the brains of individuals were removed by decapiting and were fixed in carnoy solution (Celis 1984). The concentration of the structural proteins in the neuron and glia cells in different centre of hypothalamus (LN, PVN, VMN, LPO, SON) were determinated by Gerstain (1979) method. The protein concentration was evaluated as a pg (picogram) protein amount in 1 μm^3 cellular surface. For this purpose, the interference microscope (BINAM L 211) was used. The average was provided by measuring the protein concentrations in 150 neuron and glia cells from each sample in cytoplasm and nuclei separately. The determination of the protein concentration was done according to Bratski (1966) method. The formula below was employed to determine the protein concentration.

$$m = (f_0\text{-}f).s.0{,}017.t$$

m= dry substance weight,

(f_0– f): transition difference of the light wave through the structure measured by fon,

s; the surface of the measured structure (μm^3),

t: width differences of the crossection.

The field of neuron the diameter of the biggest and the smallest body and nuclei caliber perpendicularly to there cells were measured by means of MOV -1 15 ocular micrometer (Gerstein 1979).

The analysis of variance was employed for the evaluation of all the data by using SAS (13) package programmer. The differences among the groups were determined by the Duncan's't' test (Steel, 1980).

This study was approved by The Ethic Committee of the Faculty of Medicine, Yüzüncü Yil University. Further, these studies were supported by the University Grant Commission of Yuzuncu Yil University.

Findings

As seen in table 1, it was observed that the concentration of the cytoplasmic proteins in neurons of nucleus lateralis increased significantly ($P<0.01$) after a 3 days starvation, but there was not statically significant difference in the concentration of the cytoplasm and nuclei proteins in glia cells compared to the control. The concentration of the cytoplasmic and nucleic proteins in the neurons of nucleus lateralis significantly decreased ($P<0.01$) after 5 days starvation compared to the control group, whereas the protein concentration in the cytoplasm of the glia cells significantly increased ($P<0{,}001$).

It was observed that the concentration of nucleus proteins of neurons in the paraventricular centre increased after 3 and 5 days starvation ($P<0.01$) while the cytoplasmic proteins in glia cells increased after 5 days starvation ($P<0.001$) compared to control. To recover the starvation, the animals were fed for 15 days. After 15 day recovery, the concentrations of cytoplasmic and nucleic proteins in the neurons of LN were returned to the level of control group,

whereas the concentration of the nucleic proteins in neurons of VMN and PVN remained in the high level. (Table 1)

As seen in Table 2, not any significant change was observed in the concentration of the cytoplasmic and nucleic proteins in the neurons and glia cells in all the active nuclei of hypothalamus during a 1-3 day starvation. However, it was observed that the protein concentration in the nuclei of the neurons in VMN decreased significantly ($P<0.01$).

After 5-day dehydration, it was observed that the concentration of the cytoplasmic and proteins in the neuron and glia cells of all the active centre of hypothalamus decreased significantly. This condition was more obvious in the nuclei of neurons (Table 2).

The retoration of cytoplasmic and nucleic protein in supraoptic, paraventricular, lateral preoptic and lateral centre of hypothalamus was provided after 45 days, in the neurons of ventromedial centre after 15 days and in the glia cells after 7 days of water supply. (Table 2)

Discussion and Conclusion

An impulse reaching to the nerve cells is received by the genetic material of the nerve cells and the memory is formed according to these impulses received. This formation is occurred by protein molecules. The protein concentrations in these cells can increase and decrease according to the changes in the impulses reaching to the new cells (Regnier, 1980).

In this study; the amount of the cytoplasmic proteins in the lateral centre of hypothalamus increased significantly ($P<0.01$) on the 3rd day of starvation. This condition indicates that the lateral centre is at the highest sensitivity as a starvation center on the 3rd they of starvation (Panin, 1983). In the first stages of the starvation, the impulses related to starvation reach the satisfaction as well as the hunger centers. The increase in the protein amount in the satisfaction center observed on the 3rd day of the starvation can be attributed to the intentional behavior of animals determined by the mutual functional relations of these centres (Barak, 1994).

On the 5th day of starvation, the protein concentration in neurons of lateral and ventromedial nucleus decreased. Anochin (1984) reported that the activity of acid peptide hydrolase's increased, but the amount of structural proteins decreased after 5 days starvation. At the same time the proteins inside cell, have been used to fulfill the catabolic activities of cells.

In paraventricular centre vasopressin, oxcytosin, neurotensin I and II are synthesized by peptiderjic neurons.

The proteins in cytoplasm are used for synthesizing these hormones and in the state of hunger the synthesis of hormones are continuous (Askerov, 1991). In this study in a 3-5 day hunger, the cytoplasmic proteins in the neurons of paraventricular centre decreased compared to control group. This state indicates that in the synthesizing of some hormones, the proteins in cytoplasm of these cells are used. The amount of proteins in cells's nuclei in this centre increased in the period of a 3 and 5 day hunger.

This situation may be explained that the cell increases the activity depending on starvation due to the transformation of the structural proteins to the free proteins (Temur, 2007). The glia cells settled in the nerves system are responsible for feeding and supporting to neurons. These cells provide necessary proteins to neuron in the different centres of hypothalamus at the first period of hunger, but in further periods the necessary proteins were

synthesized by amino acids in blood (Roytbak, 1979; Niessing, 1980). In the present study tin the centers of hypothalamus increased in parallel to the increasing starvation level. After days starvation, the restoration was observed in glia and neurons of animals fed for 15 days. The result was also supported by Askerov (1994) and Ibrahimov and Askerov's (1997) studies.

The amount of protein in both cytoplasm and nucleus of neuron and glia cells at the 1st and 3rd day of dehydration did not show any differences compared to control group. These results might be due to unchanging physicochemical structure of proteins at the 1st and 3rd day of dehydration (Chothia, 1984).

The increase of protein level in nuclei of ventromedial center' cells are related to the hormones synthesized by those cells (Askerov, 1994).

In 5th day of dehydration, the amount of protein in nucleus and cytoplasm of neurons and glia cells was significantly decreased. Because, in further periods of hunger, the proteins are degraded by acid peptide hydrolyses via spoiling structural water of structural proteins (Temur, 2005).

Proteins restoration in neuron of ventromedial centre after dehydration was provided at 15th day while it was provided at 7th day in glia cells and at 30th and 45th day in neuron and glia cells of other experimented centers. It was observed that the neurons in the ventromedial center were morphologically and physically different from those of the other centers. These neurons were reported to be reticular origin and response together to any physiologic stimulation (Askerov, 1993). Furthermore, physicochemical feature of structural proteins and waters in inner part of neuron and glia cells of the centers are different from that of ventromedial center. Namely, the proteins in these centers are more difficult restored than that of ventromedial centre (Rose, 1985).

Scientific thesis on the concentration of structural proteins in the hypothalamic nuclei under different terms of food and drinking deprivations was supported by the studies conducted in our laboratory (S.A.Alekperova, 1987; B.M.Abushov, 1984). These authors noted that changes revealed in the neurons as marked chromatolysis and vacuolization of the cytoplasm took plase under intensification of drinking deprivation (up to 5 days). In these studies a special attention attracts the fact that the above-mentioned authors studying some hypothalamlin nuclei (preoptic, supraoptic, paraventricular, laterial and so on) showed that the neurons of lateral hypothalamlin area are more sensitive to thirst and hunger states under drinking and food deprivation. These findings give a reason to come to a conclusion that the neurons of lateral hypothalamic area are to a great extent related to the regulation of aqueous-clina balance and metabolites in the body. These findings are the confirmation of I.P.pavlov's supposition of the unity of nervous centers regulating both food and water consumption (I.P.Pavlov, 1949).

As a result, it was observed that the nutrition regime was deteriorated after 5th day water restriction and the water regime was deteriorated after 3rd day of food restriction. This situation shows that there is a functional relationship between the structural proteins in nucleus and proteins in cytoplasm as well as the proteins and structural water of neurons in specific centers related to hunger and thirstiness. This also shows that there is a central mechanism responsible for the regulation of food and water intake in case of metabolite deficiency in organism.

Table 1:

The protein concentrations in the neurones and glia cells of the some centre of the hypothalamus at some periods of saturated and unsaturated (protein concentration: piko gram/ìm^3).

Groups	HYPOTHALAMUS CENTRES					
	Lateral		Ventro-medial		Paraventricular	
	Cytoplasm	Nucleus	Cytoplasm	Nucleus	Cytoplasm	Nucleus
NEURONS						
I. Group	1.48 ± 0.04	3.94 ± 0.06	1.72 ± 0.03	3.80 ± 0.02	2,20 ± 0.07	3.50 ±0.5
II. Group	1.80 ± 0.02^b	3.84 ± 0.03	1.80 ± 0.02^a	3.90 ± 0.04^a	2.10 ± 0.05	4.20 ± 0.3^b
III.Group	1.20 ± 0.04^b	3.52 ± 0.02^b	1.68 ± 0.03	3.50 ± 0.03^a	1.80 ± 0.03^a	3.97 ± 0.4^b
Restoration						
IV. Group	1.40 ± 0.05	3.84 ± 0.04	1. 39 ± 0.07^b	4.73 ± 0.12^b	2.13 ± 0.11	3.77 ± 0.05^a
GLIA CELLS						
I. Group	1.28 ± 0.05	3.81 ± 0.04	1.84 ± 0.04	4.73 ± 0.12	1.02 ± 0.06	2.70 ± 0.12
II. Group	1.30 ± 0.02	3.99 ± 0.09	1.93 ± 0.01^a	3.86 ± 0.04^a	1.03 ± 0.03	3.50 ± 0.15^c
III. Group	1.70 ± 0.05^c	3.58 ± 0.05^a	1.87 ± 0.03	3.10 ± 0.06^b	1.42 ± 0.06^c	2.61 ±0.08
Restoration						
IV. Group	1.28 ± 0.04	3.76 ± 0.03	1.83 ± 0.04	4.72 ± 0.1	1.37 ± 0.06^b	3.15 ± 0.09^a

^{a}The difference between control group and experimental group is important ($p<0.05$).
^{b}The difference between control group and experimental group is important ($p<0.01$).
^{c}The difference between control group and experimental group is important ($p<0.001$).

Table 2: The protein concentrations in the neurones and glia cells of the some centre of the hypothalamus at some periods of thirsty and unthirsty (protein concentration: piko gram/ ìm^3).

Groups	HYPOTHALAMUS CENTRES									
	Supraoptic		Paraventricular		Lateral preoptic		Lateral		Ventromedial	
	cytoplasm	Nucleus	cytoplasm	Nucleus	cytoplasm	Nucleus	cytoplasm	Nucleus	cytoplasm	Nucleus
NEURONS										
I. Group	1.45±0.04	2.31±0.05	1.52±0.04	2.54±0.04	1.30±0.02	2.26±0.03	1.22±0.03	2.31±0.02	1.30±0.02	2.94±0.04
V. Group	1.45±0.02	2.35±0.03	1.61±0.06	2.56±0.06	1.34±0.02	2.22±0.02	1.26±0.02	2.27±0.04	1.34±0.02	2.28±0.03^b
VI. Group	1.46±0.02	2.40±0.04	1.50±0.02	2.49±0.04	1.33±0.03	2.30±0.03	1.27±0.03	2.40±0.06	1.26±0.02	2.13±0.03^b
VII. Group	1.22±0.03^b	1.71±0.03^c	1.29±0.05^b	2.18±0.04^b	1.16±0.03^b	1.73±0.03^b	0.98±0.02^b	1.61±0.03^c	1.14±0.01^b	1.88±0.03^b
Restoration										
VIII.Group	1.23±0.03^b	1.71±0.04^b	1.29±0.03^c	2.21±0.05^b	1.13±0.09^b	1.94±0.04^b	1.00±0.02^b	1.71±0.03^b	1.22±0.02	2.19±0.03^a
IX. Group	1.17±0.03^c	1.76±0.05^c	1.49±0.03	2.51±0.03	1.12±0.04^b	2.02±0.06^b	1.05±0.02^a	1.84±0.04^b	1.33±0.02	2.39±0.03
X. Group	1.43±0.04	1.94±0.04^c	1.51±0.03	2.54±0.04	1.26±0.02	2.12±0.03^b	1.10±0.03^b	1.92±0.04^b	-	-
XI. Group	1.44±0.21	2.13±0.05^c	1.50±0.03	2.51±0.04	1.32±0.03	2.22±0.06	1.29±0.05	2.37±0.04	-	-
GLIA CELLS										
I. Group	1.20±0.02	2.32±0.03	1.08±0.03	2.28±0.04	1.40±0.04	2.40±0.03	1.15±0.05	2.30±0.05	1.15±0.05	2.30±0.05
V. Group	1.24±0.03	2.31±0.03	1.10±0.02	2.30±0.04	1.38±0.01	2.43±0.04	1.14±0.02	2.26±0.03	1.14±0.02	2.26±0.03
VI. Group	1.22±0.02	2.37±0.04	1.09±0.06	2.18±0.06	1.34±0.02	2.38±0.06	1.13±0.03	2.40±0.04	1.13±0.03	2.40±0.04
VII. Group	0.99±0.02^b	1.94±0.02^b	1.13±0.04	2.11±0.03^a	1.22±0.02^b	2.04±0.04^b	1.00±0.02^a	1.84±0.01^a	1.00±0.02^a	1.84±0.01^a
Restoration										
VIII.Group	0.92±0.30^c	1.91±0.30^c	1.04±0.03	2.17±0.04	1.27±0.03^c	2.16±0.04^a	1.07±0.02^a	2.11±0.02^c	1.28±0.02^a	2.27±0.03
IX. Group	1.16±0.03	1.95±0.04^c	1.04±0.02	2.33±0.03	1.27±0.03^c	2.14±0.05^a	1.12±0.02	2.01±0.04^b	-	-
X. Group	1.23±0.02	2.31±0.03	1.03±0.03	2.35±0.05	1.38±0.41	2.35±0.04	1.09±0.02	2.18±0.05	-	-
XI. Group	1.20±0.04	2.30±0.04	1.07±0.02	2.28±0.05	1.36±0.03	2.47±0.05	1.21±0.03	2.33±0.04	-	-

^{a}The difference between control group and experimental group is important ($p<0.05$).
^{b}The difference between control group and experimental group is important ($p<0.01$).
^{c}The difference between control group and experimental group is important ($p<0.001$).

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