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Brain GABA and Glutamic Acid Content in Experimental CO Poisoning

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One of the everyday risks, especially in winter season, to which we Koreans are exposed nowadays has become the poisoning with crbon monoxide (CO) which, together with other noxious substances such as SO_2, NO, H_2S, NO_2, formaldehde, etc., emanates from most Korean household heating fuel anthracite CO poisoning is now threatening hundreds, or more lives across the country every year(1) in Korea. CO poisoning has not only to do with the system of home heating and cooking devices in Korea but also to do with industry, occupational sources, motor vrnicle exhaust, tobacco smoking, etc, all over the world. It must be necessary to develop adquate socio-economic pregramming and policies to prevent the adverse effects of CO poisoning on our health, of course. Of more urgent in our opinion is to understand one very nature of CO poisoning in its basis by way of long-range scientific research, rather than impatient search for practical or immediately applicalble measures against CO poisoning most policy-makers seek. The problem of whether or not the CO poisoning result solely from anoxia, for example, has not been solved. While biochemical studies associated with CO poisoning are needed in this regard, experimental studies so far has been mostly purely biological, such as those dealing with morbidity and/or mortality as related to CO concentration(2, 3), etc. Since many of the symptoms of CO poisoning are more or less of central nervous system, and gammaaminobutyric acid(GABA) appears to be an inhibitory factor in the brain while the glutamic acid excitatory, attempts were made to demonstrate a relationship, if any, between the brain content of these amino acids and experimentally produced CO poisoning primarilly. Experimental set-ups were further extended to what have in some aspects to do with CO poisoning, i e hyperbaric oxygenation, with and without preceeding CO poisoning, hypoxic state and state of drug-induced anesthesia.

Materials and Methods

Animals Throughout the experiments male-adult albino rats weighing 190—240 g supplied from a single source of our regular breeder were used. They were raised with usual breeder's rat diet until the previous night they were brought to the laboratories on the day of use.

Prepartion of CO gas CO gas was prepared by conventional method using concentrated sulfuric and formic acid. To enough amount of hot sulfuric acid in a flak having air-tight cork stopper with two holes, formic acid from separatory funnel connected through one of the holes to the flask was dripped drop by drop. Efferv escent CO gas was allowed to escape

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through the other hole on the flask to another air-tight flask with two exits containing saturated KOH so lution to bubble. The whole system was flushed with generated CO gas for several minutes to expel the existing air. The CO gas was collected in calibrated bottles under water at atmospheric pressure.

Preparation of approximately 1% CO gas in the air The stopper of one 1 CO gas bottle was replaced under water with that having two exit tubings. One of these tubings was connected to the Douglas-type vinyl bag of reasonably accurately 100 1 capacity, to which the air was previously force-driven by a small fan. Through the other tubing of CO gas bottle, water was allowed to flow by hydrostatic pressure to push the CO gas in the bottle into the air bag. Such 1% CO gas was readily made whenever the gas needed.

Exposure of the animals to the CO gas A large paper chromatogrphic jar was remodeled for use as an exposure chamber. The capacity of the chamber was adjusted to 30 1 by filling water in it, providing enough room to accomodate usually 8 rats at a time of exposure. The lid of the chromatographic jar was replaced with that having inlet and outlet vents on it. Rats were introduced to the exposure chamber with the soda-line bag, and the 1% CO gas rapidly perfused wia inlet vent by mechanical suction motor exerted through the outlet vent of the chamber. After the air in the exposure chamber was replaced by Co gas, the flow rats of the 1%CO gas was adjusted by suction motor power at approximately 11/minute, keeping the concentration of CO gas constant. Exposure varied in duration from 120 to 150 minutes depending upon the time of onset of symptoms of sever poisoning consisting of panting respiratory movement and enlarged, prominent eyes. If exposure goes on further, those rats with the symptoms of poisoning almost always expired, occasionally with terminal opisthotonic convulsions, after which ressuscitation by manual artificial respiration was of no use. During exposure the animals were carefully observed and the time of onset of symtoms noted. At around 15 minutes following the 1% CO gas perfusion, most animals looked not any more normal: the commonest first sign of poisoning was unsteadiness, some of the rats actively stroking their own nasal area by the fore-paws, and some showing excitatory rampant movement in the chamber. Very often around 20 minutes after exposure began the paws and tail of the animals became typically cherry-red in celor. From then on until the terminal stage descibed above, most rats became calm with their furs raised in crouching posture, with very few occasional movement and large sighing respiration, the last becoming more frequent as exposure continues. These were only general impressive description, for animals showed varied individual sensitivity to exposure to 1 %CO gas.

Hyperbaric oxygenation Rats removed rapidly from exposure chamber following a rapid flushing of the chamber with the air for a few minutes by suction, and nonexposed normal rats were placed in the hyperbaric oxygen bomb of clinical type available at Seoul National University Hospital. The interval between the removal of rats from the CO gas exposure chamber and the introduction of oxygen gas to the pressure bomb took usually not more than 10 minutes. The duration of oxygen compression was usually less than 5 minutes. Animals were treated in the pressure chamber with administration of pure oxygen at a pressure of 3 atmosphere absolute, and the duration of treatment was 60 minutes as a minimum and 90 minutes maximally at full pressure.

Hypoxic state Rats were placed in an empty dessicator of approximately 8 1 capacity and the

lid of the dessicator replaced to keep the dessicator air-tight. Soda-lime bag to absorb the CO_2 exhaled from the animals and a beaker of water were placed in the dessicator with the animals. Hypoxic state so produced usually lasted 5 hours in the dessicator.

Anesthesia Sodium pentobarbital dissolved in physiological saline was initially injected to the rats intraperitoneally in amount of 30-35mg/kg body weight. If animals wake up before 90 minutes, supplementary injections of the anesthetics were given to prolong the anesthetic state to 90 minutes.

Extraction of brain free amino acids Rats treated variously as well as their controls were sacrificed by decapitation, when whole blood was also collected. The brains were excised and kept in the freezing compartment of a refrigerator at -15°C for several minutes until homogenization.

The frozen brain was trimmed to devoid of cerebellum, weighed and homogenized with 2 ml of ice-cold 0.01 N HCl as described by Maynert (4) and subjected to the procedure described by Maynert et al(5) with minor modification of ours as follows. The brain homogenate in dilute HCl was transferred completely to a polyethylene tube with aid of divided portions of 6 ml of absolute ethanol, allowed to stand at 0°C for an hour or more, and then centrifuged at 16,000× g for 10 minutes at room temperature. In the method described by Maynert et al(5), this centrifugation was to be done at 0°C; however, according to Hakkinen et al(6) preparation of samples at room temperature did not cause any change in the brain content of free amino acids. The supernatant was saved, and the precipitate washed 3 times with 3 ml portions of 75% (by volume) of ethanol each time. The washes were combined with the first supernatant, and evaporated to dryness at around 80°C under reduced pressure generated by water suction. The dried residue was then thoroughly stirred with the combination of 1 ml of water, 2 ml of methanol and 2 ml of chloroform. The resulting upper aqueous phase, which consistently had a volume of 2.4 ml, was used for the two-dimensional paper chromatographic separation of brain free amino acids.

Paper chromatography Thirty ul of brain free amino acid extract was applied to a large rectangular sheet of Whatman No. 1 filter paper for ascending chromatography. Solvent for the first dimension was a mixture of n-butanol, acetic acid and water by the ratio (in volume) of 60:15:25, and the chromatogram developed for 24 hours at room temperature. For the second chromatography water saturated ammoniaphenol solvent(40ml water in 500 g phenol, and 1ml ammonia water for each 200 ml phenol solvent) was used. The chromatogram was developed for 14 hours and the paper dried with a fan for at least 5 hours. Standard amino acid mixture was processed like the samples.

Determination of GABA and glutamic acid The paper was dipped in 0.2% ninhydrin in acetone, allowed to dry and then heated in an oven at 90°C for 3 minutes. GABA and glutamic acid spots and blank, drea, and standard and blank area from a separate chromatogram, were cut out, placed in glass-stoppered test tubes, and heated in a boiling water bath for 5 minutes with 2 ml of 0.5% ninhydrin in 95% ethanol. At room temperature the tube content was made up for the leak of ninhydrin-ethanol vapor, and appropriate amount of water was added. After the tubes were allowed to stand for approximately an hour in the dark, the optical density of the paper-free liquid was neasured at 570mμ in a Spectronic 20 photo meter.

Determination of brain and serum total free amino acid nitregen The color developed by the reaction between amino acids and betanaphthoquinone-4-sulfonic acid in alkaline solution was the basis for the determination of free amino acid nitrogen(7). Tungstic acid filtrate of serum and the liquid-free aqueous phase of brain residue used for chromatographic spotting were made alkaline to be added with borax and naphthoquinone reagent. Excessive naphthoquinone was destroyed by treatment with thiosulfate in the colored solution acidified with acid-formaldehyde reagent.

Rusults

A total of 6 series of experiments were carried out, in each of which experimental conditions in a particular group of animals were identical. For example, the concentration of CO gas could not be same in two series of experiments, since the CO gas concentration in the present experiments was not strictly controlled by such an use of CO gas concentration analyzer. Likewise the duration of exposure to CO gas was not identical from one experiment to another, since the purpose of exposure was only to continue until the animals were unconscious on the verge of death due to CO poisoning. Results of the experiments weres ummarized in Table I and II.

Brain and serum level of total free amino acid nitrogen (Table I)The brain content of total free amino acid nitrogen in CO poisoned, hypoxic and pentobarbital anesthetized animals maintained the control level in each experiment. Exposure to high oxygen pressure in Experiment II to IV showed a general tendency of elevations as compared to respective controls, although the elevations were not statistically significant in any of the experiments. CO poisoning followed by high pressure oxygen resulted in more or less diminution in brain total free amino acid nitrogen content without statistical significance. The last finding was unique because it did not reflect either the CO effect (paralleling with the controls) or high pressure oxygen effect (higher than controls). Thus the animals exposed to CO gas followed by high pressure oxygen represented an independent, combined effect of CO poisoning and hyperbaric oxygenation.

The serum total free amino acd nitrogen content of CO poisoned animals was consistently higher than that of control in each experl

Table 1. Brain and Serum Level of Total Free Amino Acid Nitrogen

Experiment No.	Treatment	Brain (mg/100g)	Serum (mg/100ml)
I	CO-Poisoning(5)	46.39±4.15	10.75±1.45
	Controls(8)	45.55±2.01	7.12±0.43
II	CO-Poisoning(4)	45.90+2.27	11.04±2.10
	Hyperbaric Oxygenation(4)	43.66±1.58	7.60±0.32
	CO-Poisoning and O_2(4)	39.28±1.83	10.17±0.28
	Controls[4)]	42.88±1.48	6.88±0.33
III	CO-Poisoning(4)	41.74±2.90	11.54±1.46
	Hyperbaric Oxygenation(4)	53.81±1.66	7.70±0.16
	CO-Poisoning and O_2(1)	41.22	8.80
	Cntrols(4)	44.60±1.83	8.16±0.17
IV	CO-Poisoning(4)	53.05±2.95	9.85±1.27
	Hyperbaric Oxygenation(4)	48.29±1.73	7.30±0.33
	CO-Poisoning and O_2(4)	38.40±3.83	8.21±0.11
	Contrls(4)	45.56±1.45	6.62±0.21
V	Hypoxia(8)	54.20±4.13	7.60±0.37
	Controls(4)	51.36±1.64	7.1 ±0.2
VI	Pentobarbital Anesthesia(6)	44.35±1.76	6.04±0.46
	Controls(4)	47.44±1.88	6.50±0.31

* Mean±Standard Deviation.
Figure in parentheses denotes number of samples (rats).

Table II. Brain Content of GABA and Glutamic Acid

Experiment No	Treatment	GABA*		Glutemic Acid*		Mean Molar Glu/GABA Ratio
		μg/g	μM/g	μg/g	μM/g	
I	CO-Poisoning(5)	267.3±19.9	2.59±0.19	1,075.6±62.6	7.31±0.43	2.82
	Controls(8)	295.5±11.7	2.87±0.11	1,497.5±56.0	10.19±0.38	3.55
II	CO-Poisconing(4)	312.1±19.2	3.03±0.19	1,077.5±48.8	7.33±0.33	2.41
	Hyperbaric Oxygenation(4)	272.1±13.1	2.64±0.13	1,536.1±39.2	10.45±0.26	3.99
	CO-Poisoning and O_2(4)	278.9±16.3	2.70±0.16	1,546.8±40.5	10.52±0.27	3.90
	Controls(4)	357.0±12.6	3.46±0.12	1,637.5±29.1	11.13±0.19	3.22
III	CO-Poisoning(4)	291.3±20.5	2.82±0.2	1,225.3±46.4	8.33±0.31	2.95
	Hyperbaric Oxygenation(4)	241.3±15.6	2.34±0.15	1,518.0±25.8	10.32±0.17	4.41
	O-Poisoning and O_2(1)	258.2	2.50	1,406.7	9.57	3.83
	Controls(4)	308.4±17.3	2.99±0.16	1,641.9±17.9	11.17±0.12	3.74
IV	CO-Poisoning(4)	350.7±23.6	3.40±0.23	1,067.2±38.1	7.26±0.26	2.14
	Hyperbaric Oxygenation(4)	230.4±10.5	2.23±0.10	1,560.0±21.4	10.61±0.41	4.76
	CO-Poisoning and O_2(4)	217.2±26.7	2.10±0.26	1,533.6±41.8	10.43±0.28	4.97
	Controls(4)	362.0±15.7	3.51±0.15	1,782.5±22.9	12.12±0.15	3.45
V	Hypoxia(8)	292.1±18.4	2.83±0.18	1,647.5±26.4	11.20±0.18	3.96
	Controls(4)	350.8±17.1	3.40±0.16	1,490.0±30.8	10.14±0.21	2.98
VI	Pentobarbital Anesthetia(6)	331.5±16.6	3.21±0.16	1,275.1±30.6	8.67±0.21	2.71
	Controls(4)	368.4±19.1	3.57±0.18	1,680.1±24.5	11.43±0.17	3.20

* Mean-Standard Deviation. Figure in paentheses denotes number of samples

ment (P's<0.01). Hyperbaric oxygenation resulted in slightly higher values than those of control, but the rises were not statistically significant. Animal exposed to CO gas followed by hyperbaric oxygenation generally exhibited the medium values between the high content found in CO poisoning and values of controls or animals exposed to high pressure oxygen alone. In hypoxic and pentobarbital-induced anesthetic states, the serum total free amino acid nitrogen content was higher in the former and lower in the latter, respectively, than their control values, without statistical significance in both cases.

Brain GABA and glutamic acid content (Table II) While CO poisoning did not cause any change in brain GABA content, the same experimental condition caused significant(P's< 0.05) diminution of glutamic acid in all 4 experiments carried out(Experiment I—IV). Both high pressure oxygenation and CO poisoning followed by hyperbaric oxygenation provoked significant(P's<0.05) drops in GABA content in 2 out of 3 experiments (Experiment II—IV). The glutamic acid in these two experimental conditions maintained their control levels, although slight decreases were noticeable. From these data it could be apparent that hyperbaric oxygenation did restore the decreased glutamic acid content in CO poisoning and at the same time lower the GABA content which was unaffected by Co poisoning. It was of interest to look at the column in Table II showing the mean molar glutamic acid to GABA ratio. The mean molar ratios of glutamic acid/GABA of controls were all above the figure 3(range 3.22 —3.74), while those of CO poisoning well below 3 (range 2.95—2.14). In hyperbaric oxygenation both with and without preceeding CO poisoning, the figures superceeded those of controls (range 3.83—4.97). No distinct difference

was noted beween high oxygen pressure alone and CO poisoning followed by hyperbaric oxygenation.

Hypoxia caused decrease in brain content of GABA with concomitant increase in that of glutamic acid, thus raising the molar glutamic acid to GABA ratio (3.96). Although neither the decrease in GABA nor the increase in glutamic acid were statistically significantly different from the control values. Pentobarbital anesthesia showed change similar to that observed in hypoxia in GABA content with nonsignificant decrease, but the glutamic acid dropped significantly ($P<0.05$) to almost the same degree as observed in CO poisoning.

Discussion

Results in the foregoing section should be an expression of a facet of the brain metabolism in CO poisoning and other related conditions as reflected in the brain free amino acids with special reference to GABA and glutamic acid.

It is well known that the brain is the unique tissue containing a significant concentration of GABA, althotgh the occurrence of this amino acid other than brain tissue cannot be excluded. Strong interest in GABA stepped in with the report of Hayashi et al (8) that the amino acid inhibited convulsions in dog induced by electrical or chemical stimulation; and Killam and Bain's (9) finding that semicarbazide-induced conv ulsions in rats were associated with a decrease in brain GABA concentration.

Glutamic acid is also found in significant amount in the mammalian brain. Aside from its important role in the elimination of ammonia in the brain, it serves as chief source of GABA by a process of decarboxylation by the intervention of enzyme L-glutamic acid decarboxylase(10):

$$\underset{\text{L-Glutamic Acid}}{HOOC\,CH_2\,CH_2\,CH(NH_2)\,COOH} \;\underset{\text{L-Glutamic Acid Decarboxylase}}{\uparrow\downarrow}\; \underset{\text{GABA}}{HOOC\,CH_2\,CH_2\,CH_2\,NH_2} + CO_2$$

The relation between glutamic acid and GABA is further visualized in the following scheme:

glutamic acid again through the aid of GABA-transaminase, which catalyze the reaction reversibly. The succinic semialdehyde dehydrogenase of the brain(11) oxidizes the succinic semialdehyde to produce the succinic acid, which could easily be metabolized via tricarboxylic acid cycle. For the glutamic acid via GABA, succinic semialdehyde, and succinic acid to enter the tricarboxylic scid cycle, the pathway formsso-called GABA shunt, the significance of which in the brain metabolism is controversial[12,13]. At any rate, while most neurons in central nervous sytem are inhibited by GABA, they are stimulated by glutamic acid [14,15]. Thus the molar ratio of glutamic acid/GABA may well be retarded as an index of neuronal excitability of brain, the normal-values of which obtained in the present experiments lying in a narrow range of 3.22-3.74.

It was of note in our results the glutamic acid/GABA ratio was decreased in CO poisoning, ranging from 2.95-2.14. Although signs of coma we observe in human CO poisoning could not be reproduced in the CO poisoned animals of the present experiments, the glutamic acid/GABA ratios in these animals were decreased

$$\underset{\text{GABA}}{HOOC\,CH_2\,CH_2\,CH_2\,NH_2} + \underset{\text{Alpha-Ketoglutaric Acid}}{HOOC\,CH_2\,CH_2\,CO\,COOH} \;\underset{\text{GABA-Transaminase}}{\uparrow\downarrow}\; \underset{\text{Succinic Acid Smialdehyde}}{HOOC\,CH_2\,CH_2\,CHO} + \underset{\text{Glutamic Acid}}{HOOC\,CH_2\,CH_2\,CH(NH_2)\,COOH}$$

showing depressive effect of CO poisoning on the brain. The brain GABA and glutamic acid content as well as the glutamic acid/GABA ratio under CO poisoning were somewhat similar to those under pentobarbital anesthesia. The successful use of pure oxygen at high pressure was reported for the treatment of CO poisoning about a decade ago (16). The role of high pressure oxygenation treatment in CO poisoning seemed to be more than symptomatic, for the glutmic acid/GABA ratios were increased in the animals exposed to CO followed by hyperbaric oxygenation as well as in the animals subjected to high pressure oxygen alone. This must be an indication that hyperbaric oxygenation had exerted at the level of brain biochemistry to reverse the change induced by CO poisoning to its genuine effect to raise the glutamic acid/GABA ratio.

The ultimate mechanism whereby alterations in brain content of GABA and glutamic acid were produced by CO poisoning, hyperbaric oxygenation, etc, may not even be appreciated or understood by the present type of experimental studies. It was only conjectured, however, that the reduction in glutamic acid, at least, in CO poisoning could well be the diminished formation of this amino acid from alpha-ketoglutaric acid due either to reduction of this keto-acid in tricarboxylic acid cycle, to the diminished GABA-transaminase activity in the brain, or to both of these. The aerobic tricarboxylic acid cycle intermediate, alpha-ketoglutaric acid, should be decreased in amount in the prevalence of anoxia under CO poisnoing; actually the oxygen consumption of the brain slices from CO-poisoned animals was less than that of slices from normal ones(17). And Kim(18) reported recently the decreased serum transaminase activity of rabbit in CO poisoning, albeit the relation between the transaminase of serum and intracellular GABA-transaminase was unknown. Normal or under nomal GABA content excluded the possibility of glutamic acid depletion to produce GABA unless excessive turnover of this amino acid is postulated.

The precise mechanism underlying the CO gas poisoning in humans as well as in experimental animals are unknown. It is generally believed that anoxia is the main factor causing death and other symptoms in cases of CO poisoning. The mechanism of anoxia caused by CO gas depends upon its ability to hinder oxygen transport by blood hemoglobin. There seems to exist two distinct mechanism by which CO gas result in anoxia: first by blocking of hemoglobin for oxygen transport, since the affinity of hemoglobin is far more greater for co than it is for oxygen; and more partciularly, by the "shift to the left" which CO gas causes in the dissociation curve of oxyhemoglovin. The oxygen partial pressure at the tissue level, where oxygen content of the capillary blood has been reduced to approximately 40%of saturation, the "shift" can effect substantial decrease in the oxygen tension of blood supplying the tissue. This shift is known to increase the hazarodous effect of CO toxicity at high concentration of CO-hemoglobin (around 40%) as compared to an equivalement reduction of blood oxygen by hypoxia(19).

However, it entirely unknown whether or not the toxic effect of CO resides solely in anoxia. In discussion of CO poisoning in general, the toxic effect, other than anoxia which is taken for granted too generously, of CO gas itself is too often neglected, despite the fact that one should naturally think of possible effect of CO gas besides anoxia. We are declined to careless use of the term "CO anoxia" for CO toxicity.

In pursuing the brain metabclism under CO posioning and other related cnoditions as reflected

in the brain level of free amino acids with special reference to GABA and glutamic acid, therefore, our attention was keen toward whether or not the results observed in CO poisoning came out similar to those observed in hypoxia, an entity we deemed close to anoxia. If results concerning any of the parameters we had chosen came out in common from these two experimental conditions, the CO toxicity were to ascribable to anoxia primarily until otherwise proved different, but if they came out differenct from each other, the CO toxicity should be an independent manifestation of an entity different from anoxia.

The first-hand difference in the results noticeable from each condition was found in molar glutamic acid/GABA ratio, the mean values in CO poisoning ranging from 2. 95 to 2. 14 whereas that in hypoxia being 3. 96. The significant drops of glutamic acid content seen in CO poisoning contrasted with the increase in hypoxia (without statical significance though), and the decrease of GABA was more marked in hypoxia than in CO poisoning; thus as result of these the molar glutamic acid/GABA ratio was far more greater in hypoxia than that CO poisoning had different brain biochemistry manifested at least in the parameters we had chosen from that of hypoxia, and that the toxicity of CO poisoning is not solely responsible to anoxia as is generally believed. Incidentally the reason why glutamic acid was decreased only in CO poisoning and not in hypoxia despite the prevalence of anoxic state in both conditions could not be known. But this is the very reason why we differentiate, on the basis of different response of CO poisoning and hypoxia to anoxic state, the two conditions from each ether.

The inclusion on our experiments of determination of serum total free amino acid nitrogen was to see, if by any chance, there ixist correlation between this parameter and brain total free amino acid nitrogen. Brain and serum data of total free amino acid nitrgen, however, did not reveal any consistent relation between these two. In fact it has been well known that free amino acids, with the exception of glutamine, suffer from inability to move freely across the blood-brain barrier (BBB). We do not suppose any of the experimental conditions imposed in the present work had destroyed the normal blood-brain barrier to allow free movement of amino acids from either side. The characteristic patterns of alterations with the serum values seen in many of experimental conditions could rather be the reflection of hydration states of each animal group, although attempts were made to control the temperature and moisture of the exposure chamber to amtch with those of outside.

Summary

Brain metabolism under CO poisoning and other related conditions in rats as reflected in the brain level of free amino acids with special reference to GABA and glutamic acid was studied. GABA and glutamic acid were determined paper chromatographically.

Results obtained were as follows.

1. In CO poisoning GABA conten remained control level while the glutamic acid was diminshed, giving decreased moaer glutamic acid/GABA ratio. The same tendency was also found in pentobarbital anesthesia.

2. In hyperbaric oxygenation, both with and without preceeding CO poisoning, glutamic acid maintained the control level while GABA showed a tendency to decrease. This may be an indication that hyperbaric oxygenation had exerted in brain biochemistry to reverse the change induced by CO poisoning to its genuine effect.

3. Results concerning hypoxia differed in many aspects from those of SO poisoning, sug-

gesting that the toxicity of CO poisoning was not solely responsible to anoxia.

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—國文抄錄—

실험적 일산화탄소(Co)중독과 대뇌 GABA 및 Glutamic Acid*

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金 漢 燮

일산화탄소(CO)까스 중독을 위주로 몇가지 실험조건하에서 대뇌대사의 일면을 엿보기위하여 흰쥐에서 대뇌 GABA 및 glutamic acid 함량을 측정하였다.

실험동물군은 대략 다음과 같이 처리되었다.

대조군

1% CO까스 노출군

3기압(절대기압) 고압산소 노출군

1% CO까스 노출후 3기압 고압산소 노출군

저산소상태하군

pentolarbital 마취군.

GABA 및 glutamic acid는 여지 크로마토그라피로 정량하였다.

실험결과는 요약 다음과 같았다.

1. 일산화탄소중독시 대뇌 GABA량은 대조치와 비슷하였으나 glutamic acid량은 현저히 감소함으로써 glutamic acid/GABA 분자비는 대조치보다 저하되었다. 이러한 경향은 Pentabarital 마취시에도 관찰되었다.

2. 고압산소노출은 일산화탄소중독을 미리 시켰을때나 단독처리시를 막론하고 대뇌 GABA량을 감소케 하였고 glutamic acid량은 대조치수준을 유지케 하였다. 이러한 사실로 미루어보아 일산화탄소로 야기되는 대뇌 유리아미노산량의 변화는 고압산소로 다시 변화되는듯 하였다.

3. 저산소상태하에서 얻은 결과와 일상화탄소중독시의 결과가 일치하지 않았던 점으로 보아 일산화탄소중독은 단순한 무산소증에만 연유하지 않을 것으로 추론되었다.

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