

Distribution of catechol compounds in human brain

It is probable that norepinephrine and dopamine have some important function in the brain¹⁻³. 3,4-Dihydroxyphenylalanine (Dopa) also may have some importance as a precursor of these amines because it may pass into the brain through the blood-brain barrier.

Recently evidence has been obtained of the occurrence in brain of dopa as well as norepinephrine and dopamine, with the use of a new method for the simultaneous determination of these three compounds⁴.

TABLE I

CONCENTRATION OF DOPAMINE, NOREPINEPHRINE AND DOPA IN DIFFERENT PARTS OF THE HUMAN BRAIN ($\mu\text{g/g}$ WET WEIGHT)

The value is the mean in the brains of three humans who died by strangulation, HF intoxication and brain softening. Standard deviation is presented in parenthesis. The values without standard deviations are the results of single estimation.

	<i>Dopamine</i>	<i>Norepinephrine</i>	<i>Dopa</i>
G. precentralis	0.13 (0.13)	0.06 (0.01)	0.00 (0.00)
G. postcentralis	0.17 (0.14)	0.03 (0.01)	0.03 (0.03)
G. frontalis sup.	0.11	0.01	0.00
G. frontalis med.	0.03	0.02	0.00
G. frontalis inf.	0.02	0.02	0.00
G. parietalis sup.	0.07	0.00	0.00
G. parietalis inf.	0.02	0.01	0.03
G. occipitalis lat.	0.05 (0.02)	0.01 (0.00)	0.03 (0.03)
G. temporalis sup.	0.08	0.02	0.01
G. temporalis med.	0.06 (0.02)	0.01 (0.01)	0.03 (0.02)
Oliva	0.05 (0.03)	0.04 (0.02)	0.03 (0.01)
Pyramis	0.17 (0.01)	0.01 (0.01)	0.03 (0.01)
Medulla oblongata	0.17 (0.06)	0.14 (0.03)	0.02 (0.01)
Pons (ventral)	0.07 (0.03)	0.02 (0.00)	0.01 (0.01)
Pons (dorsal)	0.08 (0.06)	0.15 (0.02)	0.03 (0.01)
Corpora quadrigemina	0.07 (0.06)	0.15 (0.03)	0.04 (0.04)
Nucl. caudatus	5.74 (0.41)	0.04 (0.01)	0.02 (0.01)
Putamen	8.25 (0.82)	0.07 (0.01)	0.03 (0.01)
Pallidum	1.01 (0.17)	0.02 (0.01)	0.02 (0.02)
Insula	0.08 (0.05)	0.04 (0.02)	0.01 (0.01)
Substantia nigra	0.38 (0.16)	0.07 (0.02)	0.04 (0.01)
Nucl. ruber	1.17 (0.16)	0.23 (0.05)	0.08 (0.00)
Capsula interna	0.38 (0.32)	0.04 (0.01)	0.03 (0.01)
Thalamus rost.	0.11 (0.05)	0.00 (0.00)	0.02 (0.02)
Thalamus med.	0.46 (0.26)	0.09 (0.05)	0.02 (0.00)
Thalamus lat.	0.30 (0.22)	0.04 (0.04)	0.03 (0.03)
Hypothalamus	1.12 (0.45)	1.11 (0.22)	0.06 (0.01)
G. cinguli	0.00 (0.00)	0.05 (0.00)	0.01 (0.01)
Sept. pell. et Fornix	0.07 (0.06)	0.17 (0.08)	0.02 (0.01)
Corpus callosum	0.05 (0.01)	0.00 (0.00)	0.01 (0.00)
Fimbria hippocampi	0.13	0.04	0.02
G. hippocampus	0.04 (0.03)	0.02 (0.01)	0.01 (0.00)
G. dentatus	0.12 (0.03)	0.03 (0.02)	0.01 (0.01)
Nucl. amygdalae	0.13 (0.04)	0.06 (0.02)	0.01 (0.01)
Brachium pontis	0.17 (0.11)	0.01 (0.01)	0.00 (0.00)
Monticulus	0.03 (0.01)	0.01 (0.00)	0.02 (0.00)
Cerebellum	0.00 (0.00)	0.01 (0.01)	0.02 (0.00)
Nucl. dent. cerebelli	0.03 (0.01)	0.01 (0.01)	0.04 (0.02)
Gl. pineale	0.50	0.10	0.04
Plexus chorioideus	0.11 (0.02)	0.04 (0.02)	0.07 (0.02)

Although the distribution of norepinephrine in dog brain was investigated by VOGT *et al.*², little is known concerning the distribution of dopamine. This paper gives results (Table I) on the distribution of norepinephrine, dopamine and dopa in human brain; the concentrations of the three compounds as stated were estimated in the same sample by our chemical procedures.

The method consists of four steps: extraction with acidic ethanol, purification with aluminum oxide, separation with a weakly acidic resin (Amberlite IRC-50) and fluorimetric estimation after applying the ethylenediamine⁵ and trihydroxyindole reactions⁶.

Because human brains were obtained 10 to 20 h after death, changes of the concentration of these amines may have occurred. However, in preliminary experiments the concentrations of norepinephrine and of dopamine in guinea-pig brain were shown to remain constant for 24 h after death. This suggests that the results obtained are valid.

The concentration of dopa, norepinephrine and dopamine in various anatomical regions of the human brain are listed (Table I). Norepinephrine was found to be concentrated in the hypothalamus and the dorsal parts of the pons and oblongate medulla which correspond to the reticular formation. This result is similar to that found by VOGT *et al.*² for dog brain.

Dopa was not localized in any particular part of the brain.

Dopamine was very definitely localized. Extraordinarily high concentrations of this amine were found in the putamen of the lentiform nucleus and caudate nucleus which are the neostriatum. These parts belong to the extrapyramidal system. Besides these nuclei, the pallidum of the lentiform nucleus and red nucleus which are other regions of extrapyramidal system, and the hypothalamus and thalamus contain considerable amounts of dopamine.

This pattern of dopamine distribution is essentially different from that of norepinephrine; dopamine is concentrated in the subcortical nuclei, and norepinephrine in the hypothalamus and in more caudal regions. The difference of the distribution of these two amines suggests that, in addition to being a precursor of norepinephrine, dopamine has a different function in the brain from that of norepinephrine. Dopamine is considered to function in the extrapyramidal system which regulates the central motoric function. The problem of how this amine is related to this system remains unsettled, however, and is now under investigation.

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