MONOAMINERGIC SYSTEMS IN THE HUMAN LIMBIC BRAIN

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INTRODUCTION

There exist several reports in the literature on the distribution of serotonin (5-HT), dopamine (DA) and noradrenaline (NA) in the limbic system of laboratory animals (Paasonen et al., 1957; Brownstein et al., 1974; Saavedra et al., 1974). In addition to these reports, which are based on chemical analyses of the brain monoamines in question, there exists a wealth of pertinent information obtained by means of the histofluorescence technique for the visualization of monoamines in brain tissue (Dahlström & Fuxe, 1964; Fuxe, 1965; Lindvall & Bjorklund, 1974). However, to our knowledge, there exist no systematic biochemical studies of the monoamine levels in limbic areas of the human brain. This report deals with the distribution of 5-HT, DA and NA in limbic areas of the neurologically normal human brain, thus providing a suitable framework for future studies on the behaviour of these monoamines in the limbic brain of patients with neurological and/or psychiatric illnesses.

I. MATERIAL AND METHODS

A. Human Brain Material

All postmortem human brain material analyzed in this study derived from "neurologically normal" cases, that is cases with no evidence of any psychiatric or neurological disorder. In addition, only those cases being relatively free of drug treatment and chronic metabolic disorders were deemed suitable for control purposes. Thus, the most frequent cause of death for our selected cases was firstly...
myocardial infarction, and secondly haemorrhage (accident victims). Our cases ranged in age from 19 to 77 years and the time interval between death and freezing of the brain ranged between 6 and 24 hours, being on average 15 hours postmortem. All procedures involved in the handling and freezing of human brain and the subsequent dissection of frozen brain material have been previously reported (Lloyd et al., 1974). Unless otherwise stated the nomenclature for subcortical brain nuclei is according to the atlas of Riley (1960).

B. Methods

All isolated limbic areas, cortical and subcortical, were homogenised in entirety and, whenever possible, the homogenate was divided into portions: one for 5-HT assay, another for catecholamine (CA) assay. The extraction and fluorimetric measurement of 5-HT was performed as previously described by Lloyd et al., 1974. NA and DA were assayed either by means of a radioenzymatic procedure (Coyle & Henry, 1973; Palkovits et al., 1974) or fluorimetrically, using modifications of the Trihydroxyindole method (Laverty & Taylor, 1968; Farley & Hornykiewicz, 1977a), after separation on Dowex columns. In this presentation values \( < n \) have been calculated from readings less than twice the value of the respective blanks. In all instances the calculation of tissue levels was based on the performance of a known standard added to portions of the homogenate and carried throughout all procedures. All values were corrected for dilution factors and for the appropriate recoveries and are expressed as \( \mu g \) per g of wet tissue.

II. DISTRIBUTION OF MONOAMINES IN LIMBIC REGIONS OF CONTROL SUBJECTS

A. Serotonin

(1) Lower Brainstem (Table 1). The highest concentrations of 5-HT, above \( 2 \mu g/g \), were determined within the mesencephalic raphe system. This is not too surprising in view of the fluorescence histochemical evidence that a great majority of the cell bodies of the 5-HT system resides in this area (rat, Dahlström & Fuxe, 1964; monkey, Hubbard & DiCarlo, 1974a; human (fetus), Nobin & Bjorklund, 1973 and Olson et al., 1973). However, it is of interest to note that in the human brain nuclei presumed to be richly innervated with 5-HT terminals, such as the nucleus interpeduncularis and the area of the nuclei paranigralis + parabrachialis pigmentosus, had concentrations of 5-HT less than half those found in the 5-HT cell body areas of the mesencephalic raphe. This is in clear contradistinction to the nigro-striatal DA system, the cell body area (substantia nigra) containing less monoamine than the terminal area (caudate-