THE ROLE OF THE BASAL GANGLIA IN NEUROPSYCHIATRIC DISORDERS

Essay
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BY

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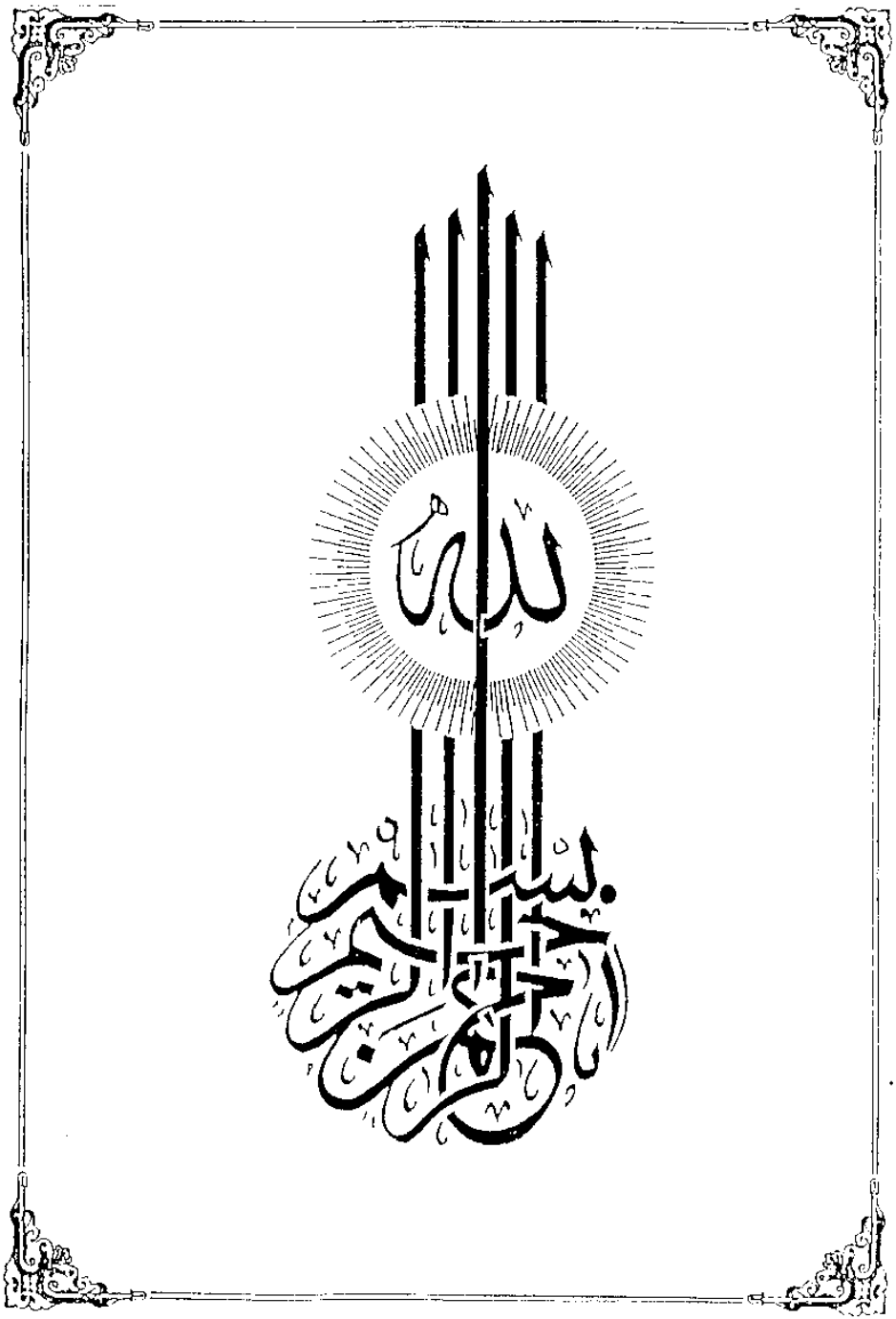
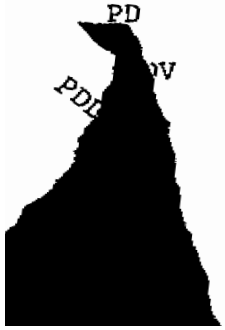


LIST OF ABBREVIATION

^{18}F-FDG	[^{18}F]-Fluoro-2-deoxy-D-glucose
5-HP	5- hydroxytryptophane
5-HT	5- hydroxytryptamine
6-FD	^{18}F-6 fluorodopa
^{99m}TC-HMPAD	99 md,1 hexamethyl propylene amine oxime
A10	Ventral tegmental area
Ach	Acetyl choline
BG	Basal ganglia
BTX	Botulinum toxin
CAMP	Cyclic adenosine 3.5 monophosphate
CD	Cranial dystonia
CMT	Chronic motor tic
CT	Computed tomography
DA	Dopamine
DRD	Dopa responsive dystonia
DSM III$^{(R)}$	Diagnostic and statistical manual of mental disorders 3rd edition (revised)
EAA	Excitatory amino acid
EEG	Electroencephalography
EOD	Early onset depression
EOS	Endogenous opiate system
FC	Frontal cortex

GABA	Gamma amino butyric acid
GAD	Glutamic acid decarboxylase
GPe	Globus pallidus external part
GPi	Globus pallidus internal part
HD	Huntington's disease
HVA	Homovalinic acid
IBZM	^{123}I-iodobenzamide
ITD	Idiopathic torsion dystonia
LCAS	Levedopa/carbidopa/ascorbic acid solution
LCMR Glc	Local cerebral glucose metabolic rate
LD/CD	Levedopa/carbidopa
LOD	Late onset dep.
MCPP	M-chlorophenyl piperazine
MPTP	1-methyl-4-phenyl 1,2,5,6 tetrahydropyridine
MRI	Magnetic resonance imaging
MRS	Magnetic resonance spectroscopy
MSA	Multiple system atrophy
NE	Norepinephrine
NMDA	N-methyl-D-aspartate
OCB	Obsessive compulsive behavior
OCD	Obsessive compulsive disorder
OCS	Obsessive compulsive symptoms
PD	Parkinson's disease
PDDV	Progressive dystonia with diurnal variation



PET	Positron emission tomography
PFLC	Prefrontal lateral association cortex
PKM	Parkinsonism
POD	Pure obsessional disorder
PSP	Progressive supranuclear palsy
QEEG	Quantitative electroencephalography
rCBF	regional cerebral blood flow
rCMR Glc	regional cerebral glucose metabolic rate
RIMA	Reversible monoamine oxidase inhibitor
SC	Subcutaneous
SCH	Subcortical hyperintensity
SL	Sublingual
SNc	Substantia nigra pars compacta
SNr	Substantia nigra pars reticulata
SPECT	Single photon emission computed tomography
STN	Subthalamic nucleus
TS	Tourette's syndrome
VBR	Ventricular brain ratio
VIM	Ventral intermediate nucleus
WD	Wilson's disease

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INTRODUCTION

The basal ganglia, as a group of nuclei in the interior of the brain, have extensive connections with almost all regions of the brain with two main connecting circuits related to the caudate nucleus "the cognitive loop" and the putamen "the motor loop" **(Williams et al., 1989).**

They were thought to be only involved in the initiation and control of movement, but it now seems clear that, they are also involved in a number of neuropsychiatric symptoms including psychosis, depression and dementia **(Kaplan & Sadock, 1991).**

Recently the relations of several neuropsychiatric disorders to dysfunctions of the basal ganglia became more clear through the introduction of the neuroimaging techniques which were not otherwise available and so, more detailed structural and functional changes could be detected.

The commonest neuropsychiatric disorders involved are, Parkinsonism, schizophrenia, mood disorders, obsessive compulsive disorder, generalized anxiety disorder, Tourette's syndrome, Huntington's disease, Wilson's disease, tardive movement syndromes and dystonic syndromes.

An evident relation between parkinson's disease and basal ganglionic dysfunctions, has been known and more informations about its pathophysiology are needed to reach a proper way of management.

The relation of Schizophrenia to the basal ganglia was based on observations of drug response which need further clarification for understanding its underlying mechanisms.

Obsessive compulsive disorder was linked to the basal ganglia through its close association with Tourette's syndrome and new evidences are essential to know about its neurochemical basis.

Other disorders such as Huntington's disease, Wilson's disease were related to the basal ganglia as they showed constant structural brain changes reached through postmortem studies, but dystonic syndrome was suggested to be related also to basal ganglia dysfunction as movement disorders which is lacking structural changes except in what was recently found in secondary dystonia.

Tardive movement syndromes, are movement disorders that usually results from continuous use of neuroleptic medication in neuropsychiatric patients, its relation to the basal ganglia ought to be more clarified.

Mood disorders were also related to structures of the basal ganglia, as it has numerous interconnections with the limbic system, the seat of human emotions.

Anxiety disorders and delusional disorders had not been well studied to link or dislink them to the basal ganglia, so other disorders will be stressed upon on the review.

Aim Of The Work

1- To review the literature about the basal ganglia in neuropsychiatric disorders.
2- To review the recent diagnostic data about disorders of the basal ganglia guided by the neuroimaging and other techniques.
3- To provide new lines of management and follow up of cases based on biological changes found in these disorders.

ANATOMY OF THE BASAL GANGLIA

In each cerebral hemisphere is a group of large subcortical nuclei included in the general term basal ganglia. These structures are the caudate nucleus, lentiform nucleus, amygdaloid complex and the claustrum. The caudate and lentiform are commonly grouped as the corpus striatum, the lentiform being devisable into an internal globus pallidus and an external putamen. The caudate nucleus resembles the putamen in structure, together they are the neostriatum or striatum.The globus pallidus or paleostriatum is often named pallidum.

*** The Caudate Nucleus:**

Is an arcuate mass in the floor of the anterior horn of central part of lateral ventricle and the roof of the inferior horn. Its anterosuperior end is the massive head, narrowing at the interventricular foramen into the arched body which continues to curve and tapers into the ventrally directed tail, merging at its apex with amygdaloid body. Its lateral surface is flat and adjoins the internal capsule. Anteriorly, the head of caudate is fused with the putamen just above the anterior perforated substance. The external capsule separates the tail from the globus pallidus.

*** The Lentiform Nucleus:**

Is like a biconvex lens. In section, it has two parts differing in colon, the larger lateral darker part is the putamen, the smaller medial part lighter tint is the globus pallidus. Lateral to it the external capsule separating it from the tenous grey matter of the claustrum, between it and the insular subcortical white matter the extreme capsule.

Medial to the lentiform nucleus is the internal capsule, separating it from the thalamus behind and the caudate head in front. Anterior, superior and posterior to the nucleus is the corona radiata, more anteriorly it is separated from the amygdaloid body by the ansa peduncularis.

Anteriorly, the putamen is continuous with the caudate's head. The globus pallidus is separated by the external medullary lamina from the medial aspect of the putamen. The internal medullary lamina divides it into smaller medial and lateral parts (Pallidum I & II) **(Williams et al., 1989).**

*** Connections of corpus striatum:**

The neostriatum (putamen and caudate nucleus) is the main afferent receiving station,which projects to the globus

pallidus. The latter provides the main efferent projection; but some afferent paths leave the neostriatum directly. Also the globus pallidus receives other afferents.

*** Afferent connections to the striatum are mainly from:**

1- **The cerebral cortex:** Corticostriate fibres from a widespread system converging from almost all parts of cerebral cortex to caudate and putamen, each part of cerebral cortex projects to a specific sites in caudate putamen complex, most projections are from the ipsilateral sensorimotor cortex mainly and to a least extent from ipsilateral visual cortex but some striatal sites receive projections from restricted regions of sensorimotor cortices in both hemispheres. Corticostriate fibres form type I synapses with dendrites and stomata of striatal neurons and are probably excitatory.

2- **The thalamus:** Thalamostriate fibres are derived from nucleus medialis dorsalis. Some fibres passing directly to end in the caudate nucleus, other traverse the caudate or skirt it to the internal capsule between its fibres to the putamen.

3- Substantia nigra: nigrostriate fibres are an important afferent system to the striatum and globus pallidus which have prominent relation to the genesis of Parkinson's tremors, from neuroanatomy and neuro-pharmacology, this relation is confirmed and suggested that its neurons utilize dopamine as transmitter.

These fibres from neurons in the pars compacta and reticulata of substantia nigra ascend through the caudate nucleus, to the internal capsule, some fibres reach the caudate nucleus. The remainder containing to the putamen and globus pallidus. Other afferents may reach the striatum from the subthalamic nucleus and nearby neural aggregate.

Striatofugal connections are mainly to:

1- Globus pallidus 2- substantia nigra 3- Thalamus

Both caudate nucleus and putamen project in a topical manner to neurons of the globus pallidus;the lateral putamen projects only to the external pallidal segment, its more medial part and the caudate nucleus projecting either to both pallidal segments or to the internal segment alone. Other striatofugal connections include projections to subthalamic nucleus and restricted parts of the inferior olivary nucleus, but these are uncertain.

*** Afferent connections to the globus pallidus:**

Are topically organised striatopallidal fibres from the putamen and caudate nucleus as noted

1- Subthalamic nucleus, its fibres reach mainly pallidum I.

2- Substantia nigra; nigropallidal fibres.

3- Thalamus; thalamopallidal fibres arrive from intralaminar, centromedian and dorsomedial thalamic nuclei.

Pallidofugal system is the largest outflow and form a complex groups of paths, the main are being:

1- Ansa lenticularis 2- Fasciculus lenticularis.

3- Fasciculus thalamicus 4- Fasciculus subthalamicus.

5- Descending fibres.

The main destinations are:

1- The thalamus mainly nucleus ventralis anterior.

2- Subthalamic nucleus and other subthalamic centers including zona incerta, entopeduncular nucleus, and nucleus of prerubral field.

3- Substantia nigra.

4- Red nucleus.

5- Midbrain reticular formation.

6- Inferior olivary nucleus

(Williams et al., 1989).