Surgical Anatomy of the Putamen

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Abstract : An anatomico-topographical study of the putamen was performed on the cerebral hemisphere of 25 adults. The mean diameters of the putamen were: 44 mm anterioposterior, 41 vertical and 8.5 mm horizontal. A 30x20 mm cortical area in the insula middle third was projected precisely on the external surface of the putamen. We consider that the transinsular approach to the putamen provides more advantages than the transfrontal approach.
Key Words : Insular cortex, Neostriatum, Putamen.

INTRODUCTION

Currently, the surgical treatment of Parkinson's Disease (PD) aims to remedy dopaminergic system deficiency. This goal can be achieved with adrenal medulla, superior cervical ganglion, and embryo or foetal substantia nigra implants into the neostriatum through a transfrontal approach by stereotaxic (1, 12) or open microsurgical techniques (13, 16). However, in PD the dopamine levels are comparatively lower in the putamen than in the caudate nucleus (14, 21).

Based on this observation, on February 17, 1988 we used, for the first time, an innovative method: an adrenal medulla transplant to the putamen through the insula and omentum over the insular lobe (18).

In this publication, we present only the anatomical findings of the putamen and their relationship with the insula, as an alternative method for implanting dopamine-productive tissues in the putamen.

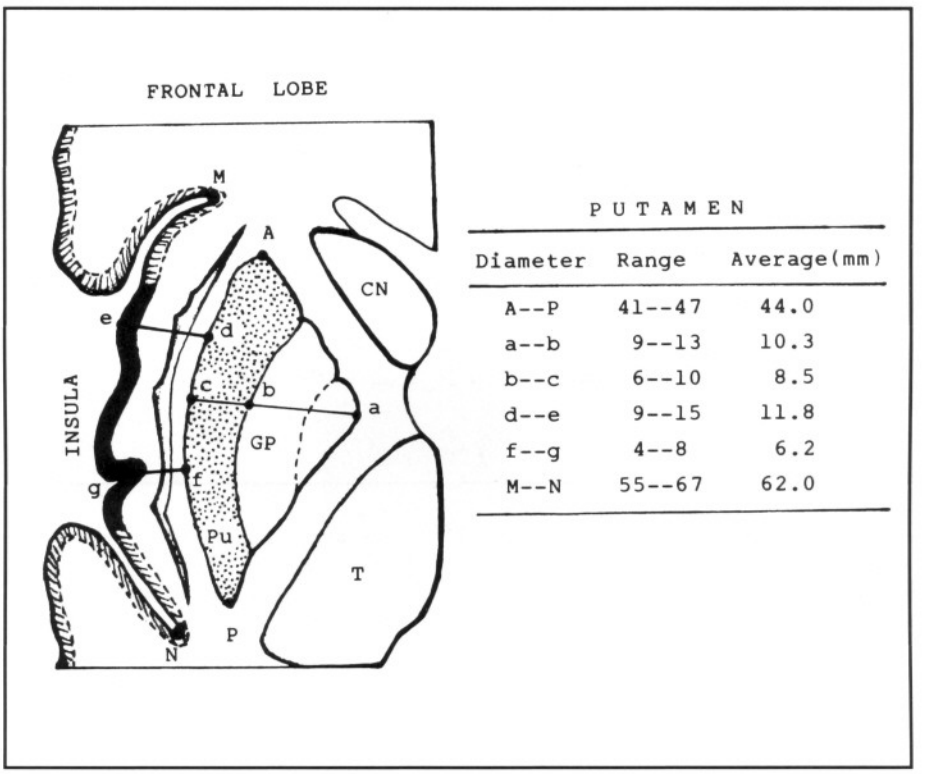
MATERIALS AND METHOD

Fifty hemispheres obtained at autopsy from 25 adults, 30 to 68 years of age, were studied. Of the 25 human cadavers, 16 (64%) ranging in age from 50 to 68 years. None had neurological disease. The hemispheres were fixed in a 10% formaldehyde solution for 4 days. In all cases putamen measurement were been made through horizontal and coronal sections. The anterioposterior and vertical diameters and the width of the putamen were determined, as well as the projection and relationship of the external surface of the putamen with the insular cortex.

RESULTS

The putamen has a meniscus shape and is joined to the anterioinferior part of the head of the caudate nucleus, forming a common body of the same colour. Once isolated, the anterioposterior diameter of the putamen is between 41 to 47 mm (mean, 44 mm) and the vertical diameter 38 to 44 mm (mean, 41 mm). Thus, the ellipsoidal shape external surface of the putamen is convex also. The putamen is wider in the anteriosuperior than on the inferioposterior part, with a mean of 8.5 mm.

In 36 cerebral hemispheres (72%), the putamen measurement was asymmetrical being larger on the left side. In 22 hemispheres from people over 50 years of age, the diameters were average or below average (figure 1). Inside and in front of the central sulcus of



PUTAMEN

Diameter	Range	Average(mm)
A--P	41--47	44.0
a--b	9--13	10.3
b--c	6--10	8.5
d--e	9--15	11.8
f--g	4--8	6.2
M--N	55--67	62.0

Fig. 1 : Horizontal section through the basal ganglia showing the distance of the putamen to the insular cortex. CN, caudate nucleus; Pu, putamen; GP, globus pallidus; T, thalamus.

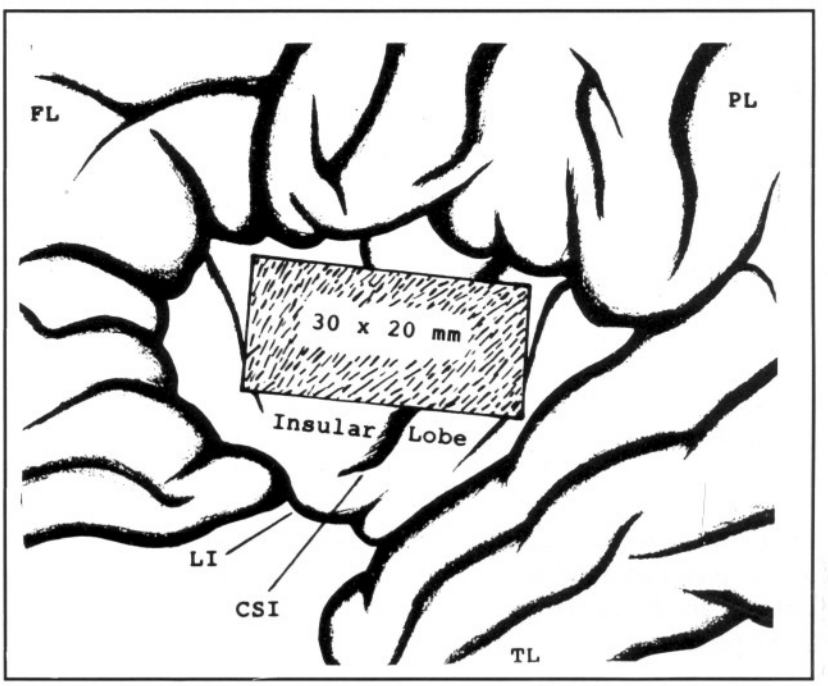


Fig. 2 : Lateral view of the cerebrum with exposure of the insular lobe. The rectangular area projects exactly over the external surface of the putamen. FL, frontal lobe; PL, parietal lobe; TL, temporal lobe; LI, limen insulae; CSI, central sulcus of the insula.

the insula, there is a rectangle 30x20 mm, projected directly on the external surface of the putamen (figure 2). This structure is 4 to 8 mm (mean, 6.2 mm) from the central sulcus and 9 to 15 mm (mean, 11.8 mm) from the remaining insular cortex. The parenchyma that separates the putamen from the insular cortex is formed by the external capsule, the claustrum and the extreme capsule. When the pia mater that covers the insular cortex is removed, several arterial branches are observed which penetrate perpendicularly the cortex and the subcortical structures of the insula.

DISCUSSION

In humans, the putamen is Ameniscus-shaped structure with a volume of 6,690 mm^3(9). It is formed by two cellular types: a) small Golgi type II neurons that end inside the same nuclei, and b) large multipolar neurons whose axones reach the globus pallidus and substantia nigra (5, 15). A ratio of 164 small neurons for each large neuron has been reported (11). To date, all PD treatment techniques to implant dopaminergic grafts into the neostriatum, have used a transfrontal approach through stereotactic (1, 12) or open craniotomy (8, 13). Therefore, the grafts are implanted in the caudate nucleus more often than in the putamen, due to a more accessible surgical approach. However, from the physiological (4, 6) and neurochemical (10, 14, 21) points of view the putamen is more important than the caudate nucleus in relation to motor control. This observation was the basis for a procedure to implant adrenal medulla in the putamen through a transinsular approach (18, 19). In addition, anatomically, as the distance between the putamen of insular cortex is shorter (19) when an omentum graft is implanted in the insula (3, 18-20), there is a better possibility in the revascularization of the putamen. On the whereas the transfrontal approach provokes more parenchymatose damage in the frontal lobe, causing higher morbidity and mortality, particularly when open craniotomy is used (2, 8, 17).

Considering these factors, we believe that the transinsular approach to the putamen has the following advantages:

1. A shorter distance between the putamen and the insular cortex;

2. A large surface of the putamen is exposed for the implant;

3. Less risk of damage to the internal capsule; and

4. There is a better chance of revascularization of the insular subcortical parenchyma and the putamen through the medullar (22) and omental (3,7) arteries. When the omentum is placed in the insular cortex (20).

Our results support the conclusions of Kish et al (10), who considered the putamen the most appropriate structure to apply the grafts in PD patients. The transinsular pathyway provides better possibilities for implanting more grafts to the putamen and increasing vascularization, leading to of better functioning and survival of the graft.

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