

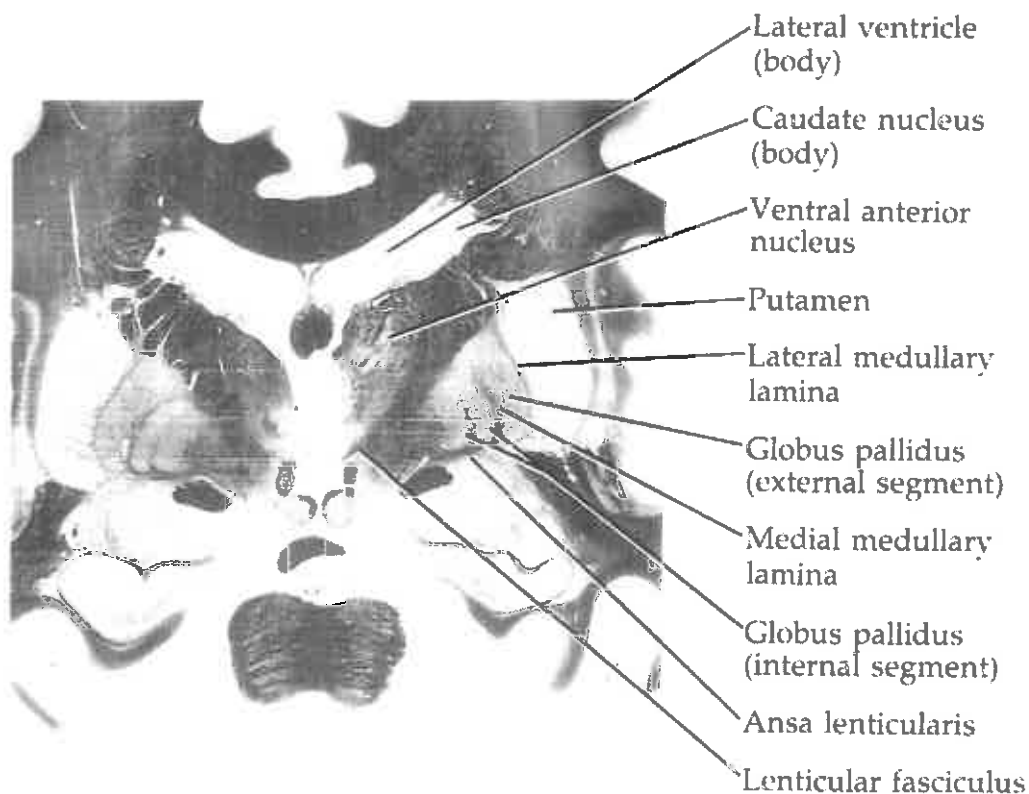
Appendix A

Parcellation of the GP: GPi & GPe

Once the globus pallidus has been traced, the GP may be parcellated into its external (GPe) and internal (GPi) segments using the medial medullary lamina as a guide.

In his discussion on the gross anatomy of the dorsal pallidum, Carpenter explains the white matter boundaries of the GPi and the GPe:

A thin lateral medullary lamina lies on the external surface of the pallidum at its junction with the putamen. A medial medullary lamina divides the globus pallidus into medial and lateral segments (Carpenter 337).



This schematic taken from Martin's *Neuroanatomy: Text and Atlas*, displays a myelin-stained frontal section of the globus pallidus (Martin 282). Note how the lateral medullary lamina separates the putamen from the external segment of the GP, whereas the medial medullary lamina serves to separate the GPi from the GPe.

Axial plane guide traces. Prior to placing guide traces, the axial slice on which the anterior commissure appeared most prominently is again located. The crosshairs are then set on the lowest, most prominent row of voxels comprising the AC in the left hemisphere of the image. The superior border of the medullary lamina (ML) is defined as the row of voxels just inferior to the point where the crosshairs were set. This corresponds to Mettler's assertion that the division of the internal and external portions of the GP (as determined by the medial medullary lamina) cannot be visualized in the coronal plane until just after the midline portion of the AC is no longer visible and its lateral extensions have come into view.

Figure 1, taken from the Duvernoy atlas, illustrates the clearest view of the anterior commissure (AC) as seen on horizontal section (Duvernoy 299).

Figures 2 & 3 illustrate similar axial slices as seen on the trimodal image.

When the AC is symmetrical in the axial plane, the crosshairs are placed on its most posterior row of voxels, as illustrated by **Figures 2 & 3**. When the AC appears asymmetrical, however, the crosshairs are placed in the most posterior row of voxels in the left hemisphere.



Figure 1



Figure 2

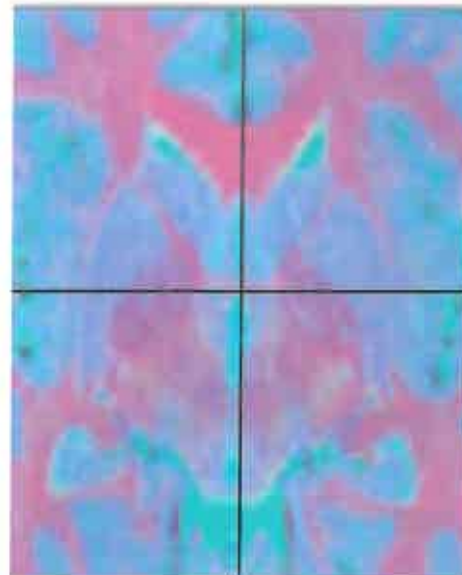


Figure 3

The coordinates for the superior border of the ML in the axial plane represent a point just caudal to the TLAC in the coronal plane, as described by Mettler. Guide tracing of the ML begins one slice superior to this point and continues superiorly, for a total of six guide traces on six consecutive axial slices. Generally, the GPI is approximately 1/3 the total size of the GP in these axial MR slices (and in the previously referenced atlases). The slope of the ML also approximates the slope of the medial boundary of the putamen. These two characteristics were used to guide the technician in laying down the ML guide traces (see figure 4).

Figure 4 depicts an axial view 1 slice superior to the clearest view of the AC. Guide traces are placed on this slice and continued on each slice in a superior direction for a total of 6 axial guide traces.

The guide trace begins at the medial border of the globus pallidus (GP), just beneath the crosshairs. A straight line, 2 voxels in length, is created moving in a lateral direction from the medial border. This line is then sloped to mimic the medial boundary of the putamen. When the line reaches the second to the most lateral column of voxels from the medial boundary of the GP, the slope ends and a vertical line is dropped down to the posterior boundary of the GP.

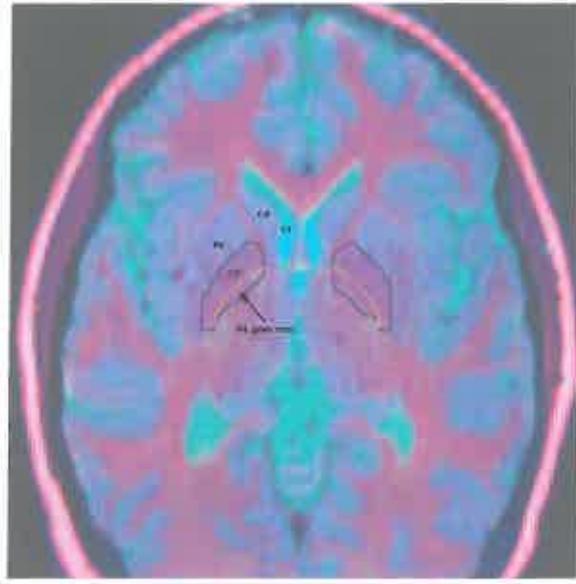


Figure 4

Figure 5 illustrates a similar horizontal view as seen in the Duvernoy atlas.

Note that the majority of the white matter separating the internal segment of the GP from the external segment of the GP (i.e., medial medullary lamina) resembles the shape of the white matter that separates the GP from the putamen (lateral medullary lamina).

Notice the subtle difference in shape between the medial medullary lamina and the lateral medullary lamina. The most medial portion of the medial medullary lamina appears horizontal for 1-2 mm, whereas the lateral medullary lamina remains arced (Duvernoy 299).

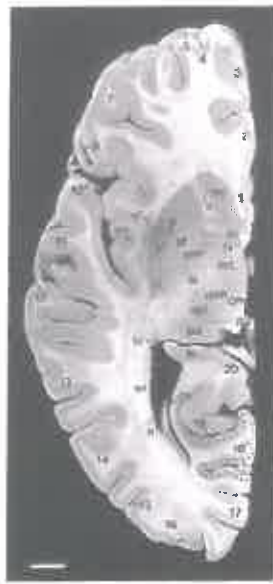


Figure 5

Coronal traces. The guide “X’s” (which represent the coordinates of the guide traces in the axial plane) generally first appear 1 – 2 slices posterior to the TLAC “anchor point” slice. These guide coordinates indicate the approximate location of the ML and are used to parcel the internal and external portions of the GP.

Figures 6, 7 & 8 illustrate the use of the guide traces in the coronal plane. The yellow “X’s” represent the boundaries established by the guide traces from the axial plane as demonstrated in **Figure 4**.

The axial guide traces are used to establish the division between the internal and external segments, while the boundaries of the whole GP are applied to establish the exterior borders of the Gpi and the GPe.

The separation of the GPi (shown in blue) & the GPe (shown in green) is established by drawing a vertical line from the inferior border of the GP to the most superior “X”. This vertical line should remain within the area outlined by the telegraphed crosses. Upon reaching the superior “X”, the remaining portion of the separation is performed by tracing in a “stairstep” fashion until one reaches the superomedial border of the GP.

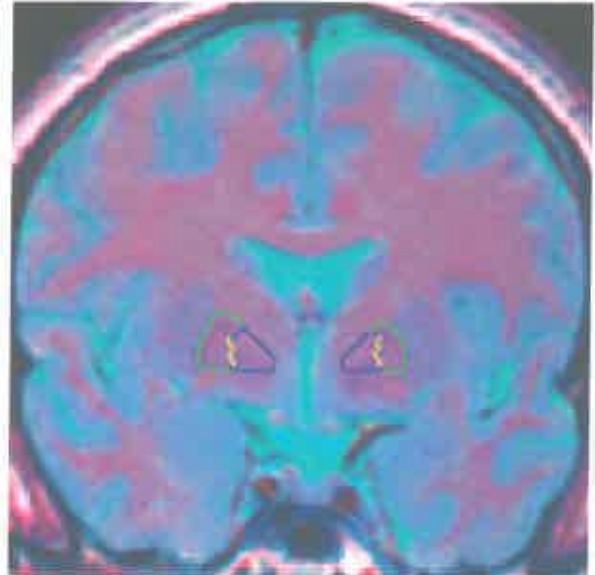


Figure 6

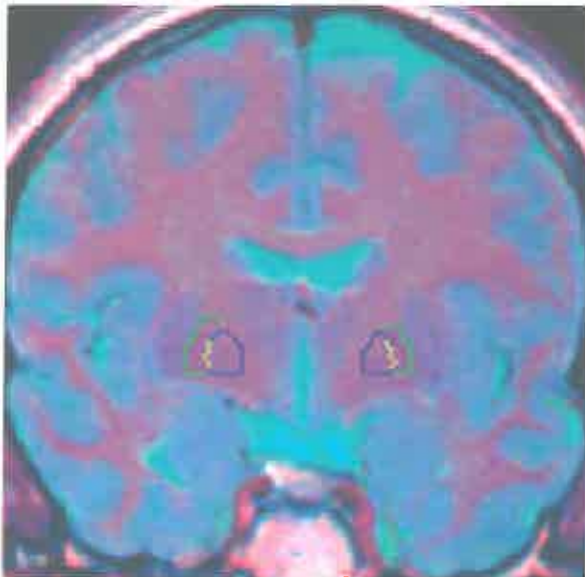


Figure 7

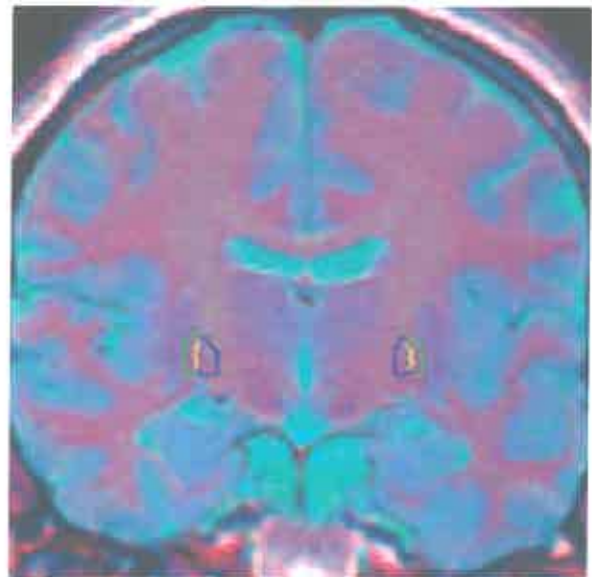


Figure 8

While the GPe is seen on all 23 slices, the GPi is generally seen on only 14 of the 23 whole-GP slices. No GPi traces should be laid down on the 2 most posterior slices given the difficulty in visualizing the structure at this point. As with the whole GP, separate traces are made for the GPi and GPe. See figure 9 for an example of the GPi and GPe traces.

Figure 9 illustrates a parceled GP in the coronal plane with the telegraphed crosses removed.

Notice the vertical segment of the line that establishes the separation between the GPe & the GPi, as described for **Figures 6, 7 & 8**.

When the vertical segment terminates, note the use of “stairstepping” to reach the GP’s superomedial border. This is illustrated quite nicely in the subject’s right hemisphere.

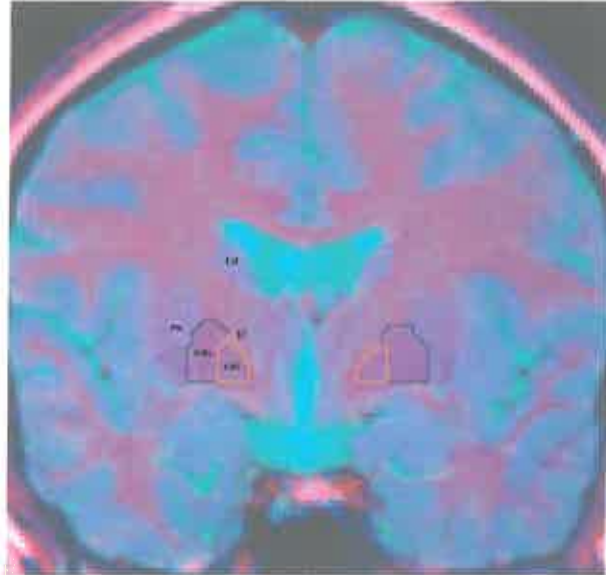


Figure 9

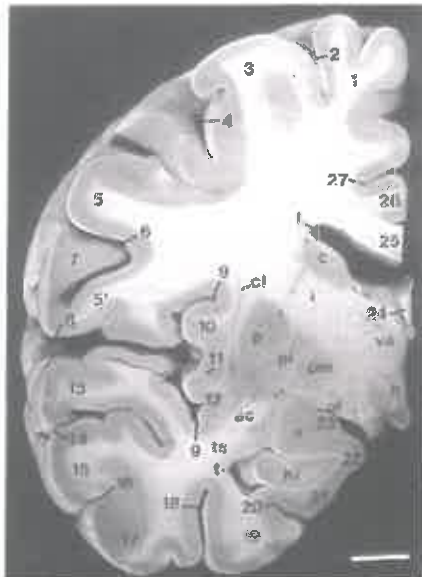


Figure 10

Figure 10 is a similar frontal section taken from Duvernoy’s *The Human Brain: Surface, Three-Dimensional Sectional Anatomy and MRI*.

Note the thickness of the fibers of the internal capsule, as it separates the GP and the putamen from the caudate.

As mentioned previously, the shape of the medial medullary lamina closely resembles that of the lateral medullary lamina.