Chapter I

The Cerebellar Dentate Nucleus

1. Anatomical Relationships

In order to understand the morphology of the dentate nucleus we need to place it in the context of the white matter core of the cerebellum in which the nucleus is embedded. The corpus medullare or white matter core of the cerebellum is a compact mass of myelinated axons covered by the cerebellar cortex. It consists of (1) the afferent projection fibers from the vestibular, spinocerebellar, pontine, olivary, raphe, and reticular pathways to the cerebellar cortex; (2) the fibers from cerebellar cortex to the cerebellar nuclei; (3) efferent projection fibers from the nuclei to elsewhere in the brain; (4) to a lesser extent, the association fibers, connecting the various parts of the cerebellum; and (5) commissural fibers, which cross from one side to the other. These are concentrated in two cerebellar commissures, a posterior one in the region of the fastigial nuclei, and an anterior one rostral to the dentate nuclei.

Since the corpus medullare is constituted in part by the afferent and efferent tracts to the cerebellum, it is naturally continuous with the three peduncles which strap the cerebellum to the brain stem: in order, the inferior cerebellar peduncle coming up from the medulla, carrying the spinal, vestibular, reticular, and olivary inputs; the middle cerebellar peduncle connecting cerebellum with the pons, carrying the pontocerebellar input from pontine nuclei and pontine reticular formation, and the superior cerebellar peduncle connecting cerebellum with midbrain. The relationship of the fourth ventricle to the cerebellar nuclei is important in the anatomy of this region. This ventricle is continuous rostrally with the cerebral aqueduct of the midbrain and caudally with the central canal of the medulla. The body of the ventricle is raised into a tentlike roof, the peak of which is called the fastigium. At its widest portion, the ventricle expands laterally into two symmetrical, tubular, lateral recesses, which curve over the inferior cerebellar peduncle. The lateral recesses have terminal apertures—the foramina of Luschka—which open into the subarachnoid space surrounding the lateral aspect of the upper medulla.

The cerebellum overlies the roof of the fourth ventricle. The white matter at the base of the cerebellum splits at an acute angle in the widest part of the ventricle to form the fastigium. The anterior leaflet, the superior medullary velum, extends rostrally to the midbrain forming the roof over the pontine portion of the fourth ventricle. The superior cerebellar peduncles form the lateral walls of the ventricle. The posterior leaflet, the inferior medullary velum, extends caudally to the medulla forming the roof over this part of the ventricles. The choroid plexus of the fourth ventricle, consisting of vascular tufts, forms two longitudinal ridges extending near the midline from the most caudal aspect of the ventricle to the inferior medullary velum. An additional strip of choroid plexus extends into each lateral recess and protrudes out of the foramen of Luschka. The foramen of Magendie, a midline aperture, is formed in the most caudal part of the ventricular roof. Through these openings the cerebrospinal fluid produced in part by the choroid plexuses escapes into the subarachnoid space.

The diamond-shaped floor of the fourth ventricle, the rhomboid fossa, is widest at the lateral recesses. The rostral and larger triangular area is pontine and its lateral walls are formed by the superior cerebellar peduncles. The lower triangular area is medullary and its lateral walls are formed by the inferior cerebellar peduncles. The middle cerebellar peduncles do not abut against...
a ventricular surface but are situated lateral to the other two cerebellar peduncles.

**Subdivisions of the Cerebellar Nuclei**

Two trends of anatomical subdivisions prevail in the literature on the cerebellar nuclei. Weidenreich (1899) described four nuclear subdivisions in rostral to caudal arrangement, in a large number of mammals and man, which have since been recognized in a variety of mammals. They were termed the medial, anterior, and posterior interpositus and lateral nuclei (Ogawa, 1935). This scheme of subdivisions has been used by a number of other authors in application to their studies in a variety of other species (Ono and Kato, 1938, cat; Ohkawa, 1957, man, primates, and other mammals; Flood and Jansen, 1961, cat; Voogd, 1964, cat; Korneliussen, 1968a, rat; Van Rossum, 1969, rabbit; Courville and Cooper, 1970, monkey). In the other scheme of nuclear subdivisions, Brunner (1919) recognized three nuclear masses in dorsal, caudal, and ventral positions. They are the nuclei medialis, interpositus, and lateralis. For more extensive reviews of the literature on these topics, please refer to Voogd (1964) and Van Rossum (1969). For the purposes of these studies, the cerebellar nuclear subdivisions of the schemes used by Goodman et al. (1963) and KorneliusSEN (1968a) in the rat, and that of Courville and Cooper (1970) in the rhesus monkey will be followed.

The fundamental intention of this book is to present a comprehensive comparison of the structure, organization, and function of the simpler cerebellar lateral nucleus in the rat with the more highly developed dentate nucleus in the monkey. According to traditional terminology, the structure in the lower mammals which is the most lateral of the cerebellar nuclei is the nucleus lateralis or, more simply, the lateral nucleus. In primate and man, this structure assumes a highly folded form which parallels the great increase in neocortical mass, both cerebral and cerebellar, and deserves the term cerebellar nucleus dentatus or the dentate nucleus. Each chapter in this book will deal with different aspects of the cytology and organization of neuronal and neuroglial elements in the lateral nucleus of the rat and in the dentate nucleus of the rhesus monkey (*Macaca mulatta*). In the descriptions, these two homologous structures will be referred to by their proper names, however, occasionally, where such distinctions are cumbersome or unnecessary, as in discussions of common organizational features, they will be referred to together as the dentate nuclei.

**2. The Rat: Gross Morphology of the Lateral Nucleus**

In order to set the stage for these comparative studies, the gross anatomy or arrangement of the lateral nucleus, its shape, size, and cellular constituents will be described. Numerical estimates are made for the resident neurons as well as neuroglial cells from morphocytometric population studies. These basic procedures are carried out on sections for the light microscope which have been stained by the Nissl method for cell bodies in the three cardinal planes.

From these sections, three-dimensional models of a pair of lateral nuclei are constructed for demonstration of gross features. The models are shown in a drawing (Fig. 1-1). The cerebellar lateral nuclei in the rat are bilateral structures, each kidney bean-shaped, with the indentation of the nucleus readily identifiable as the medially oriented hilus. In histological sections from the adult animal the nucleus measures 2500 μm from rostral to caudal poles, 900 μm from ventral to dorsal surface, and 1500 μm from medial to lateral aspects. The rostral pole of the nucleus is not smooth, but bears two or three “horns” projecting from its convex surface which extend deep into the surrounding white matter. Each horn contains a number of neurons and neuroglial cells, and these will be described in Chapter III.

In the rat, the boundaries of the lateral cerebellar nucleus have been defined according to the com-

---

1. Because the rat's brain has no pronounced pontine or cervical flexures, the three cardinal planes of the forebrain, i.e., coronal (frontal), horizontal, and sagittal serve as the three planes of the cerebellum and brain stem. All studies on the rat's cerebellum reported in this book refer to preparations made in these planes. In later chapters and where applicable, reference is made to animals placed in other stereotaxic positions for experimental injections or ablation studies. Despite the use of these positions during the experiments, in the subsequent preparation of all tissue the cardinal planes of the brain were maintained.