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T F Berns, D L Daniels, A L Williams and V M Haughton

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Mesencephalic Anatomy: Demonstration by Computed Tomography

Thomas F. Berns[1]
David L. Daniels
Alan L. Williams
Victor M. Haughton

Although gray and white matter are distinguished by computed tomography (CT) in the cerebrum and cerebellum, their resolution in the mesencephalon has not been reported. CT and anatomic sections of the mesencephalon were compared to determine the relative densities of the superior cerebellar peduncles (white matter) and red nuclei and central gray matter. The normal low attenuation of the superior cerebellar peduncle should not be misinterpreted as infarction or demyelination.

The mesencephalon contains both white (superior cerebellar peduncle and smaller fiber tracts) and gray (the red and other small nuclei and the central gray matter) matter. We studied structures of the mesencephalon that are normally distinguished by computed tomography (CT), measuring the relative densities of the structures on cross sections of brain specimens and correlated these sections with CT images. In this paper the appearances of substantia nigra, superior cerebellar penducle, and central gray matter are illustrated.

Materials and Methods

Three fixed brain specimens were cut into 5 mm thick axial sections with an electric slicer. The slices were photographed on each side and radiographed in a Faxitron cabinet radiographic unit with min-R low dose film, 20 kV, and about 18 sec exposure. Xeroradiographs were also obtained of some sections. The photographs and radiographs were compared to determine the relative density of the mesencephalic tissues.

CT images of patients were compared with the radiographs. All CT images were obtained on a GE CT/T 8800 scanner with consecutive 5 mm, or occasionally 1.5 mm, thick slices. For imaging the mesencephalon, the patients were positioned supine with their heads slightly hyperextended in the head holder. The gantry was tilted (top of gantry toward patient's feet) to produce a plane of section about $-15°$ with respect to the infraorbitomeatal line. For contrast enhancement, 200 ml of 30% iodinated contrast medium was infused intravenously over 5 min immediately before scanning and 100 ml was infused slowly during scanning. Technical factors for CT scans included 10 sec scan time, 1,150 mA, and 120 kV.

Results

The structures that can be demonstrated radiographically within the mesencephalon include superior cerebellar peduncle, substantia nigra, aqueduct, central (periaqueductal) gray matter, and red nuclei. The anatomy of the mesencephalon and in particular the red nuclei and superior cerebellar peduncles is described in detail elsewhere [1–3]. Surface structures of the mesencephalon demonstrated by CT are the colliculi posteriorly and the cerebral peduncles anteriorly [1].

Since the mesencephalon is 15–20 mm long, a CT study with 5–10 mm thick slices includes two or more slices through it. Therefore, it is convenient to

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[1]All authors: Department of Radiology, Medical College of Wisconsin, Milwaukee County Medical Complex, 8700 W. Wisconsin Ave., Milwaukee, WI 53226. Address reprint requests to D. L. Daniels.

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describe the structures in the caudal and rostral mesencephalon separately. Landmarks in the caudal mesencephalon are the sylvian aqueduct, central gray matter, substantia nigra, and the decussation of the superior cerebellar peduncles (fig. 1). In radiographs of the cut caudal mesencephalon (fig. 2), the substantia nigra and central gray matter are radiodense, while the cerebellar peduncles, like white matter in general, are more radiolucent. Therefore, CT images through the caudal mesencephalon show the peduncles as central regions of relatively low attenuation (fig. 3). Such regions of low attenuation should not be interpreted as brain stem infarction or demyelination. Ventrally the substantia nigra and posteriorly the central gray matter produce regions of greater density (fig. 3).

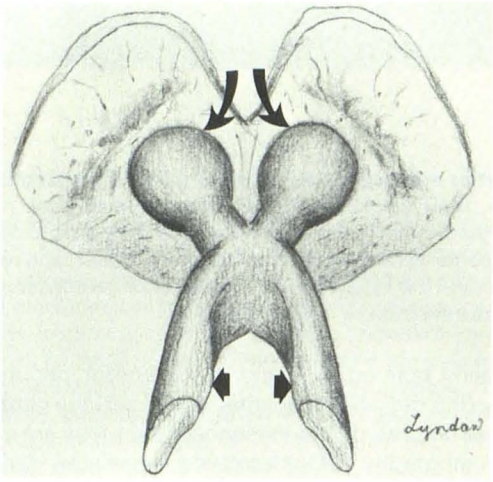

Fig. 1.—Superior cerebellar peduncles (*arrowheads*) decussating caudal to red nuclei (*arrows*).

Landmarks in the rostral mesencephalon include the aqueduct, substantia nigra, and red nuclei (fig. 4). In cut section, the red nuclei have a distinctive faint red color. Radiographs of the cut sections demonstrate that except for a thin rim of lower density tissue the red nuclei are as radiodense as the substantia nigra. CT images through the rostral mesencephalon of normal patients demonstrate the same attenuation in the red nuclei as in the adjacent substantia nigra (fig. 5).

The lower density of cerebellar peduncles presumably results from the greater lipid content in it than in the red nucleus or central gray matter [4]. Possibly, melanin that gives the substantia nigra its black color in anatomic sections also imparts the greater density seen in radiographic and CT sections.

The mesencephalon structures we have described are seen consistently, although not always clearly in our CT studies of the posterior fossa. Thin sections (5 mm or less) and relatively high exposure are required to show them. The unconventional plane of cut we use may also be necessary to demonstrate mesencephalic anatomy. It was selected because streak artifacts from bone appear to be minimized, and it has the additional advantage of being nearly perpendicular to the long axis of the brainstem, comparable to the plane of cut in many anatomic texts.

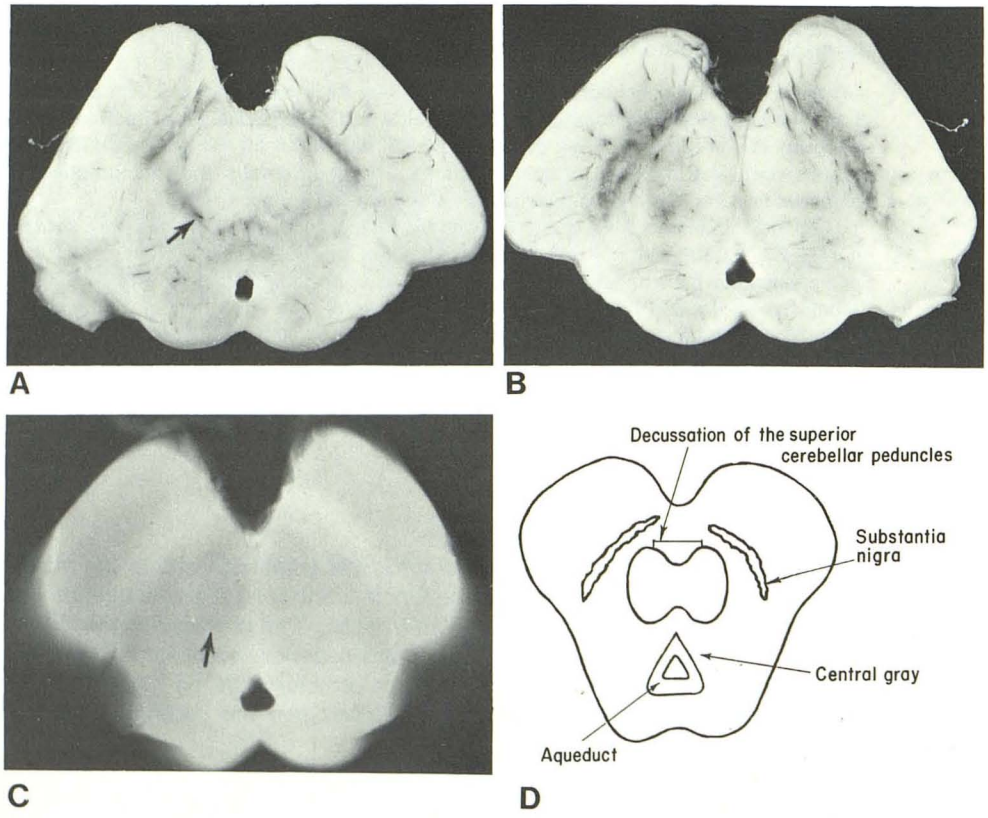

Fig. 2.—5 mm thick axial anatomic slice of caudal mesencephalon. Substantia nigra is black in photographs (**A** and **B**) and radiodense in radiograph (**C**). Central (periaqueductal) mesencephalic gray matter is also radiodense; cerebellar peduncles (*arrow*) are less dense.

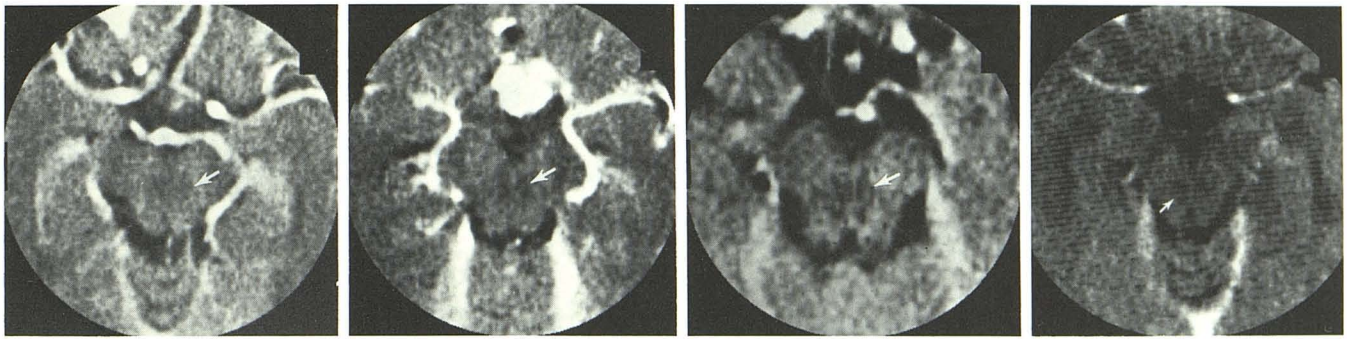

Fig. 3.—CT images through caudal mesencephalon of "normal" aneurysm patients. Low attenuation region (*arrow*) represents decussation of superior cerebellar peduncles. Substantia nigra and central gray matter, ventral and dorsal, respectively, to the brachium conjunctivum are less well defined. Densely calcified suprasellar mass in **B** was a craniopharyngioma.

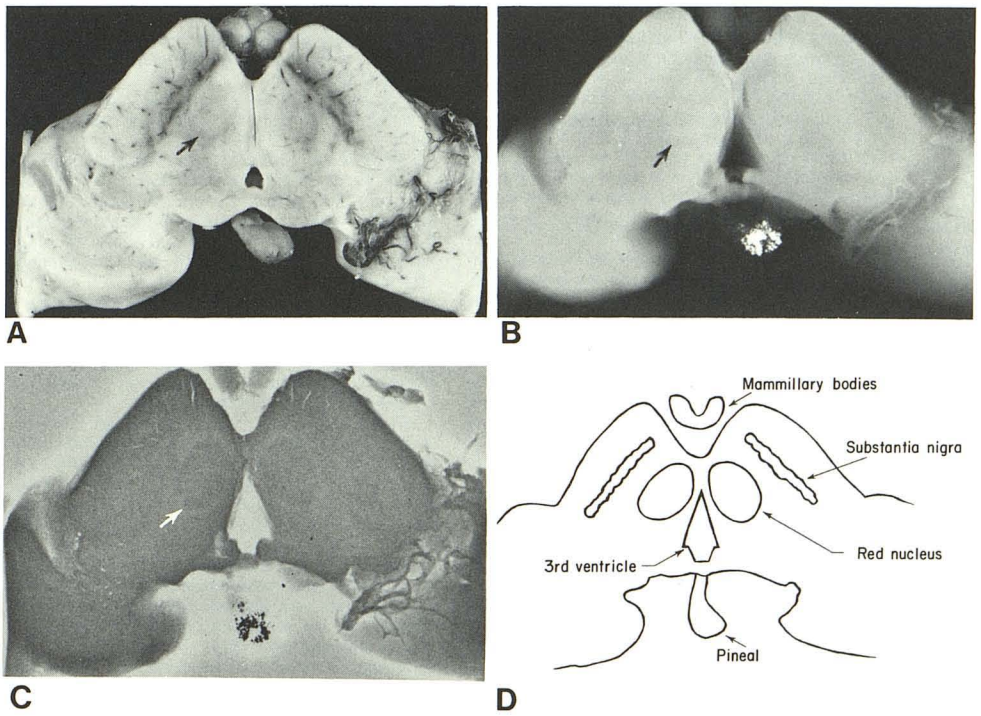

Fig. 4.—Rostral mesencephalon. Red nuclei (*arrow*) well seen in photograph (**A**) and xeroradiograph (**C**) but barely seen in radiograph (**B**). Red nuclei nearly as radiodense as substantia nigra.

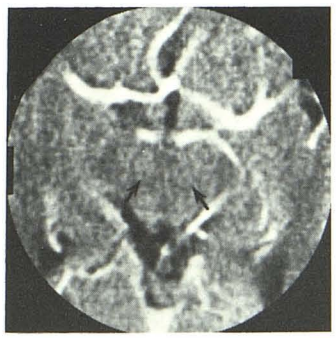

Fig. 5.—CT image through rostral mesencephalon of "normal" patient. Red nuclei (arrows), nearly isodense with substantia nigra, are barely visible.

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