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AJNR Am J Neuroradiol 1988, 9 (1) 1-3
http://www.ajnr.org/content/9/1/1

The Bright Pituitary Gland—A Normal MR Appearance in Infancy

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Signal intensities of the pituitary gland were measured on T1-weighted sagittal MR images of 25 patients younger than 20 years old. We found that the signal intensities in the eight patients who were 8 weeks old or younger were higher (shorter T1) than those in the 17 older patients. We also noted a difference in the signal intensities across the pituitary gland, the signal being higher in the posterior part of the gland than in the anterior part.

We attribute the high signal intensities to the rapid intrauterine pituitary growth, so that at term pituitary protein synthetic activity is at a maximum. Possibly, an increase in the bound fraction of the water molecules of the gland may also be present in the neonatal pituitary as compared with the older gland, but this remains to be proved. The higher signal in the posterior pituitary gland may be due to lipid in the pituicyte cells of the posterior pituitary gland.

The signal intensity of the contents of the sella turcica on T1-weighted MR images is not always uniform and homogeneous. Often, a high-intensity crescent-shaped structure is seen oriented along the posterior-inferior margin of the sella turcica. Some believe this to be fat in the sella turcica but behind the gland [1]. Others think that the high intensity is derived from the posterior pituitary itself [2, 3].

There are no published observations about the MR appearance of the pituitary gland in infants and children. In an evaluation of the sella turcica in our infant population we noted that the pituitary glands in patients 8 weeks old and younger appeared to be of a higher intensity than glands of older children. We also noted that the younger children displayed no visible intensity differences across the sella. An analysis of these observations forms the substance of this paper.

Materials and Methods

Sagittal T1-weighted (SE 600/17) MR images were obtained on a 1-T scanner in 25 patients below the age of 20 who were evaluated for reasons other than suspected pituitary disease. Eight of the patients were 8 weeks old or younger. Using region of interest analysis, signal intensities of the anterior and posterior pituitary gland and the brain were obtained. The pixels chosen for the brain were an average of the values of the pons and the inferior frontal lobe, including the gyrus rectus gray matter. The original images were scaled using the intensity of air as a reference. All the scans were 3-mm thick with an interscan gap of 1 mm. The sella turcica images were from the center of a set of 10 multislice spin-echo images, which were acquired in an interleaved order to minimize slice-to-slice interference.

Results

The signal intensities of the pituitary glands were brighter (shorter T1) in infants than in older children (Table 1). Furthermore, the signal intensity of the posterior pituitary gland measured higher than that of the anterior pituitary gland, and the

Received July 28, 1987; accepted after revision September 14, 1987.

Presented at the annual meeting of the American Society of Neuroradiology, New York City, May 1987.

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AJNR 9:1–3, January/February 1988
0195–6108/88/0901–0001

intensities of both parts of the gland measured higher than that of the brain. Representative MR scans are seen in Figures 1 and 2.

Discussion

Contrast in MR is determined mainly by the dynamic properties of the ensemble of tissue protons that determine the signal intensities of neighboring pixels. Although the concentration of tissue protons contribute to the signal intensities, their relaxation rates 1/T1 and 1/T2 dominate considerations of contrast. All the images in this study were obtained with a short TR technique, minimizing the effect of T2 relaxation. Factors that shorten the T1 relaxation time include an increase in the bound fraction of the water molecules, the amount of endoplasmic reticulum, and the quantity of protein synthetic activity [4]. There is no information available in the literature as to the state of hydration of the pituitary gland as there is for other organs and tissues [4, 5]. However, considerable information is available about the details of cell differentiation, maturation, and proliferation in the human fetal pituitary gland [6–8].

Maternal pituitary hormones do not cross the placenta; thus, the fetus is dependent upon the secretions of its own pituitary supplemented by various analogous hormones produced by the placenta [7]. Rathke's pouch becomes separated from the oropharynx by 6 weeks, at which time it establishes direct contact with the infundibulum to become the precursor of the adenohypophysis [8]. (This traditional concept may not be entirely correct since some adenohypophyseal cells may be of neural origin [9].) Cells of the anterior lobe proliferate until the lobe constitutes 90% of the total gland at midgestation and 78% at term [8].

The posterior pituitary gland develops as a downgrowth of the hypothalamus. The infundibulum can be identified at 6 weeks, and a rudimentary neural lobe is seen by 3 months [8]. Unmyelinated axons of neurons in the magnocellular nuclei of the hypothalamus terminate in the neural lobe by 6 months.

The rapid growth of the pituitary gland in fetal life is illustrated by a mean weight at 10–14 weeks gestation of 3 mg and at term of 99 mg, which is one-fifth that of the adult gland [10]. All the cellular types participate in the growth; notably, there is an increase in the number of prolactin cells in late gestation, resulting in a prolactin level at birth of 200 ng/ml to decrease to normal values at about 8 weeks [6, 7]. The number of gonadotropic cells and granules per cell also increase with fetal age, as do the number of ACTH-containing cells [6].

Thus, fetal histochemical studies have shown considerable activity in the development and differentiation of the pituitary cells and their activity during gestation. This activity would cause an increase in the endoplasmic reticulum and the quantity of protein synthetic activity, which could account for the short T1 values of both the anterior and posterior pituitary gland.

Other potential causes for short T1 values of the pituitary gland include the presence of fat, subacute hemorrhage, and slowly flowing blood. Histologic studies of the pituitary gland do not demonstrate fat cells in the anterior pituitary gland, although they are present in the posterior pituitary gland (see below). Subacute hemorrhage does not occur spontaneously within the normal pituitary gland and can be excluded as a cause of the high T1 signal intensity. Quantification of pituitary

TABLE 1: Average Intensity Values of Anterior Pituitary, Posterior Pituitary, and Brain at Different Ages

	No.	Anterior Pituitary[a]	Posterior Pituitary[a]	Cerebral White Matter[a]
Infants	8	1423 (281)	1632 (276)	968 (319)
Children and young adults	17	1098 (215)	1345 (341)	991 (166)

[a] Standard deviation is in parenthesis.

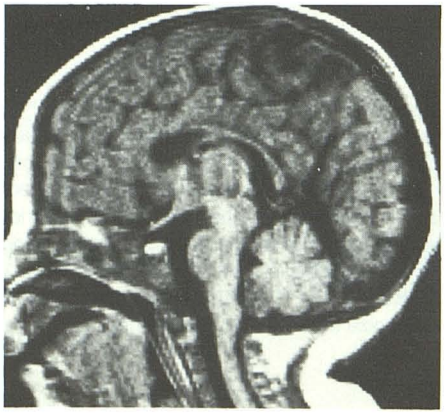

Fig. 1.—Sagittal T1-weighted (SE 600/17) MR image shows homogeneously bright pituitary gland. Age: 2 months; diagnosis: normal scan.

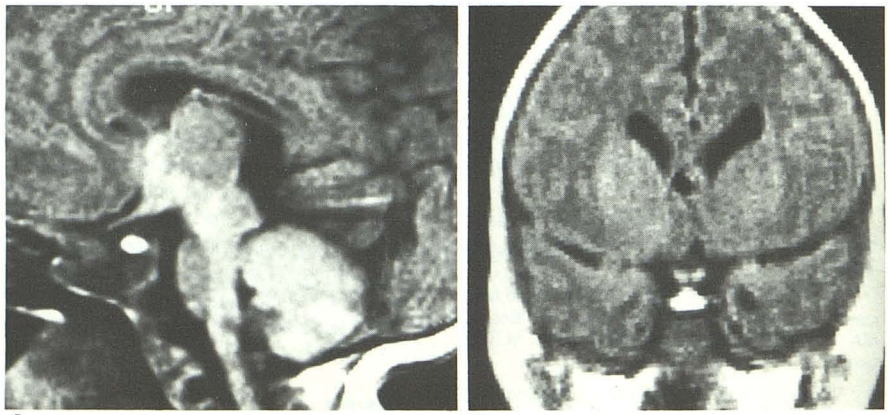

Fig. 2.—Sagittal (*A*) and coronal (*B*) T1-weighted (SE 600/17) MR images show bright pituitary gland in both planes. Age: 12 days; diagnosis: Chiari II malformation.

blood flow has been hindered because of the two vascular compartments present in the pituitary gland (neurohypophyseal and adenohypophyseal) and because the blood that enters the adenohypophysis has to pass first through the neurohypophysis [11]. Anatomic information about pituitary blood flow in humans is well established, but quantification data are sparse. In sheep, however, Page et al. [11] found that the posterior pituitary flow is very high, about 450 ml/min, 100 g/min, which is about eight times as high as cerebral cortical blood flow. Extrapolating this relatively high flow rate to humans would still not provide an adequate explanation for the bright signal (see Addendum). Region-of-interest analyses of the infants' pituitary gland demonstrate a definite but subtle difference between the anterior and posterior parts of the sella turcica. The difference appears age-related and becomes visually obvious in the older child and adult. Fat may account for the high signal posteriorly. According to Mark et al. [1], the fat is situated behind the gland but within the sella turcica. Sze et al. [12] maintain, however, that it is fat in the pituicytes, the neuroparenchymal cellular elements of the pars nervosa, that accounts for the short T1 values. Characteristic lipid droplets have been shown in these cells [13–15]. Experimentally, after several days of water deprivation and salt loading, the lipid droplets increase. This is thought to result from increased neurohypophyseal hormone release [16, 17].

In conclusion, the pituitary gland in the infant has a shorter T1 than does the gland in the older child. Furthermore, the distinction between the anterior and posterior gland, which is a notable visible feature in older patients but invisible in infants, is a true difference if signal intensity measurements are carried out. We cannot speculate as to why the differences across the sella turcica become more evident as the infant matures.

Addendum

The flow through the posterior pituitary gland of sheep is 450 ml/min, 100 g/min. Converting these values to the human, in whom the posterior pituitary gland weighs approximately 130 mg (adult), the flow would be 0.009 ml/sec. Maximal T1 signal intensity is seen on an entry slice of a multislice technique when the velocity of the flowing blood = slice thickness/TR [18]. To obtain a maximal T1 signal with a slice thickness of 3 mm and a TR of 600 msec, and assuming the pituitary blood flow is perpendicular to the slice (the portal flow of the pituitary gland is actually primarily caudally down the infundibulum to the pars nervosa), the velocity through the pituitary gland would need to be 0.5 ml/sec, which is far in excess of the estimated flow rate of 0.009 ml/sec. With multislice excitation, flow-related enhancement requires even higher velocities for deeper slices such as the center slice containing the pituitary gland.

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