Tr. J. of Medical Sciences
28 (1998) 401-406

Figen GÖVSA[1]
Gülgün KAYALIOĞLU[1]
Orhan OYAR[2]
Özlem TAŞKIRAN[1]
Tuncay VAROL[1]

Morphology of the Human Cuneus by Magnetic Resonance Imaging

Received: January 13, 1997

Departments of [1]Anatomy [2]Radiology, Faculty of Medicine Ege University, Bornova, İzmir-Turkey

Abstract: Variations of the limiting and internal sulci of the human cuneus was studied using magnetic resonance imaging (MRI) on 209 healthy individuals and the sulcal pattern of the right hemispheres of both sexes were evaluated. The internal sulci were divided into supreme, superior, middle and inferior sulci. Sulci were classified according to their localizations, courses, and terminations. Cuneus angle was measured and found as 68.84±9.74° and no sex differences was found for this angle.

Key Words: Cuneus, MRI.

Introduction

Cuneus is wedge-shaped area located on the medial surface of the cerebral hemisphere. It is bounded in front by the parieto-occipital sulcus, below by the calcarine sulcus and above by the superomedial margin of the hemisphere. Parieto-occipital sulcus commences on the superomedial margin of the hemisphere about 5cm. in front of the occipital pole and is directed downwards to meet the calcarine sulcus. The calcarine sulcus commences in the neighbourhood of the occipital pole and running forward joins the parieto-occipital sulcus with an acute angle (1).

The primary visual cortex is located in the occipital lobe in the cortex of calcarine fissure, adjacent portions of the cuneus and the lingual gyri. These are visual association areas 18 and 19. Injury to these areas may produce visual disorganization with defective spatial orientation in the homonymous halves of the visual field. Area 19 can receive stimuli from the entrie cortex; area 18 receives stimuli mainly from area 17 (2). In addition area 18 receives long arcuate fibres from the region of the frontal eye field, and this is one of the few arcuate fibre boundles, the connections of which have been clearly established (1). Neurosurgeons who must resect a nearby lesion must be careful to avoid disrupting these areas.

This study gives the magnetic resonance evaluation of the human cuneus with the parietooccipital sulcus, calcarine sulcus, and the internal sulci, searching also their relationship to gender.

Materials and Methods

This study was based on magnetic resonance examination of 209 randomly chosen patients (107 males and 102 females) without apparent neuropathology aging from 2 months to 76 years (mean 36). The examinations were performed with a GE Vectra (General Electric, USA) operating at 0.5 Tesla. T-1 weighted midsagittal images of the right hemispheres (TR:250-600, TE:17-30, NEX:1-2, slice thickness: 5 mm.) were used for the evaluation.

Criteria regarding the parieto-occipital sulcus, calcarine sulcus and internal sulci of the cuneus were mostly based on the study of da Veiga and Prates (3) while a few criteria have been added for the evaluation. The angle between the parieto-occipital sulcus and the calcarine sulcus termed as the 'cuneus angle' has also been measured.

Statistical analysis was made using Student-t test. Sex differences were searched for various parameters of the cuneus.

Result

MR evaluation of the parieto-occipital sulcus (PS), calcarine sulcus (CS), was made and presented as follows:

Parieto-occipital sulcus

Table 1. The course of the PS in the right hemispheres of both sexes.

Sex	Staright	Concave	Convex	Irregular
Male	58%	19%	14%	9%
Female	33%	25%	19%	23%

Table 2. The form of the PS in the right hemispheres of both sexes.

Sex	Regular	Irregular	Continuous	Interrupted	Simple Termination	Bifurcated
Male	55%	45%	77%	23%	83%	17%
Female	56%	44%	84%	16%	88%	12%

Table 3. The course of the calcarine sulcus.

Sex	Staright	Concave	Convex	Angled
Male	56%	7%	26%	11%
Female	64%	5%	22%	9%

Table 4. The length, termination and continuity of the calcarine sulcus.

Sex	Length		Termination		Continuity	
	Long	Short	Bifurcation	Simple	Continuous	Interrupted
Male	51%	49%	38%	62%	98%	2%
Female	52%	48%	42%	58%	95%	5%

Table 5. Horizontal sulci of the human cuneus.

Sex	Supreme	Superior	Middle	Inferior
Male	23.43%	54.68%	62.50%	70.40%
Female	15.78%	50.35%	54.38%	75.73%

Table 6. Localizations of the vertical sulci.

Sex	Anterosuperior	Anteroinferior	Posterosuperior	Posteroinferior
Male	42.31%	23.08%	19.23%	15.38%
Female	33.78%	36.49%	4.05%	25.68%

1. The course of the PS was examined and evaluated for both sexes. For concave PS, the concavity is directed externally (Fig. 1) and for convex internally (Fig. 2). Table 1 presents the course of PS in the right hemispheres of both sexes.

2. Irregular form PS is extremely tortuous, while regular form is a direct line. Bifurcation on the upper margin of the PS is shown in Figure 3. Table 2 presents the form of the PS for both sexes.

Calcarine sulcus

1. The course of the calcarine sulcus is presented in Table 3.

Here concave CS means also the the concavity is directed externally (Fig. 4) and for convex internally (Fig. 5). Angled CS is shown in Figure 6.

2. The length of the CS is classified as long and short and the termination as simple and bifurcated. The continuity of the CS was classified as continuous and interrupted. Table 4 present the length, termination and continuity types of the CS. Short calcarine sulcus means it does not reach the occipital pole. Long CS reaches the pole.

3. Termination is bifurcated in 8% of males and 11% of females (Fig. 7).

Internal sulci of the human cuneus

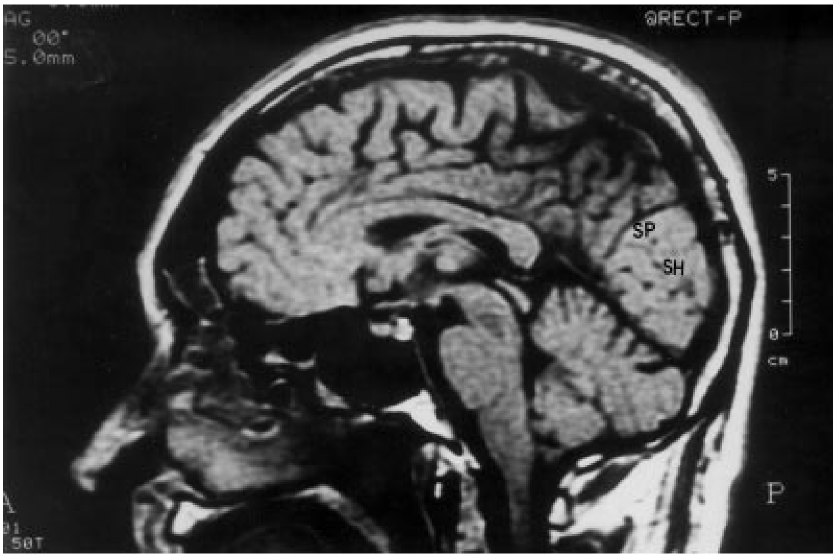

Figure 1. Concave parieto-occipital sulcus (SP) and superior horizontal sulcus (SH).

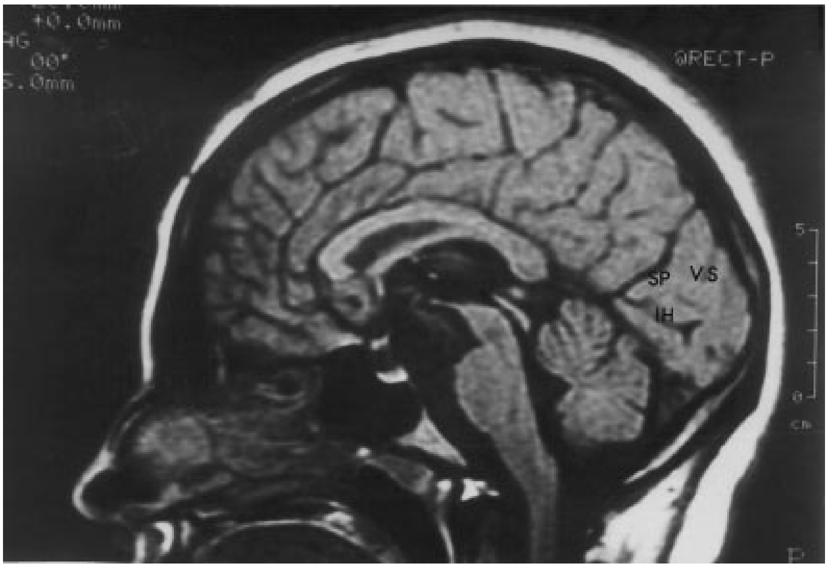

Figure 2. Convex parieto-occipital sulcus (SP), inferior horizontal sulcus (IH) and vertical sulcus (VS.).

The average number of the internal sulci of the human cuneus was 5.90±1.43 in males and 5.62±1.32 in females. Internal sulci of the cuneus were divided into 3 sub-groups as the horizontal sulci, vertical sulci, and the oblique sulci.

1. The horizontal sulci were present in 100% of the hemispheres and divided into 4 sub-groups. The number of horizontal sulci was 1-4 for males and females. The percentage of these sulci in both sexes was presented in Table 5.

The superior horizontal sulcus is shown in Figure 1, the middle horizontal sulcus in Figure 3 and the inferior horizontal sulcus in Figure 2.

2. The oblique sulci were present in 81% of females and in 84% of males. The average number of the oblique sulci was 2.82 in males and 2.11 in females. Oblique sulcus was ascending (Fig. 3, Fig. 4) in 17.83% and descending (Fig. 4) in 82.17% in males, while it was ascending in 17.99% and descending in 82.01% in females.

3. Vertical sulci were present in 82.46% of females and in 79.68% of males (Fig. 2). The position of the vertical sulci was divided into 4 sub-groups and presented in Table 6.

Cuneus angle

Cuneus angle was measured at the point where the PS was joining the CS. It was measured as 68.84±9.74˚ for both sexes, 68.80±9.44˚ in females and 68.87±10.05˚ in

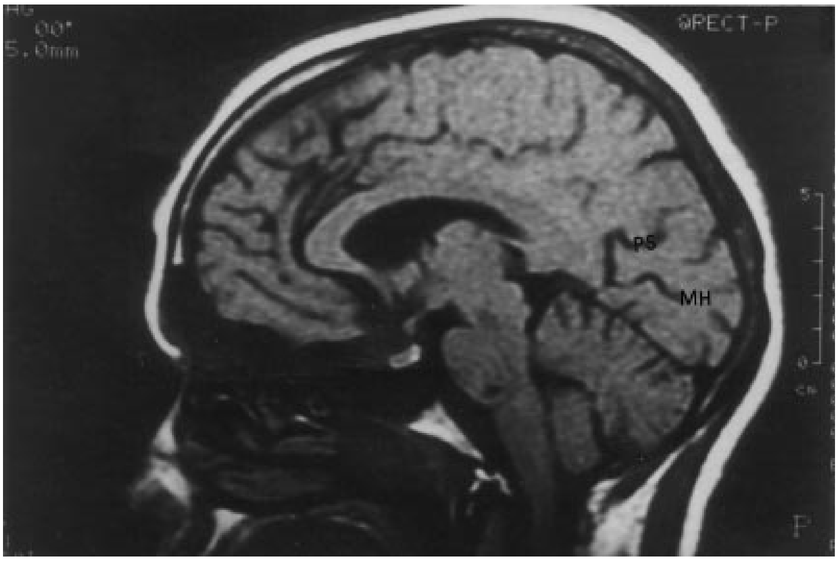

Figure 3. Irregular parieto-occipital sulcus (PS) and middle horizontal sulcus (MH).

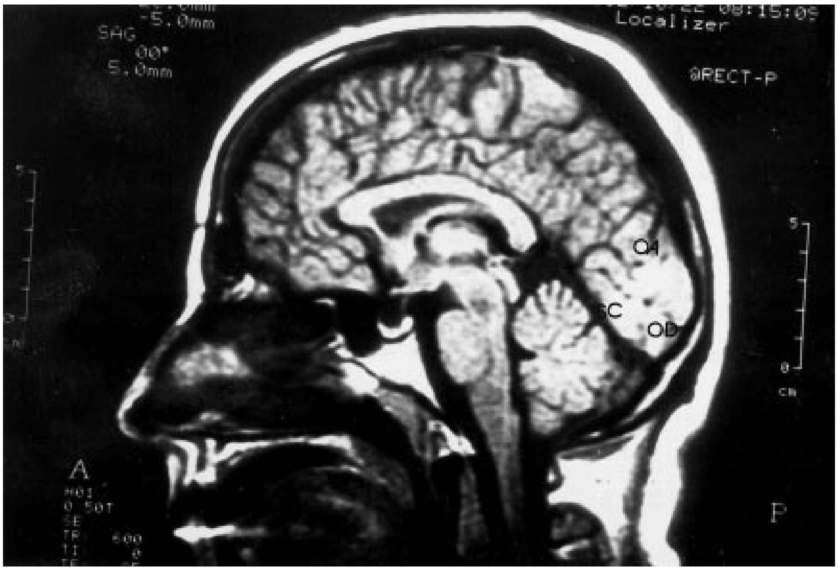

Figure 4. Concave calcarine sulcus (SC).

males.

Discussion

This study suggests that there is a considerable variability in the sulcal pattern of the human cuneus. This variablity occurs highly between individuals. Sex differences have been found in the course of the PS. Straight types was predominant in males. No significant difference was found in the form, length, termination and continuity of the PS between sexes.

Straight type CS was predominant in females while no other sex difference was found for the CS. Anterosuperior localization was predominant in males, while anteroinferior localization was predominant in females. No sex differences was found in the horizontal sulci.

Da Veiga et al. studied on 39 caucasian and 41 non-caucasian brains obtained from autopsy (3). They found the straight type PS predominant in males, which is in concordance with our study, while they did not find any sex differences for the CS.

They found ascending oblique sulcus predominant in females and descending oblique sulcus predominant in males, while we could not find such a difference.

Sulci of the cuneus have been mentioned by Gray (1) as cuneus is intended by one or two small irregular sulci.

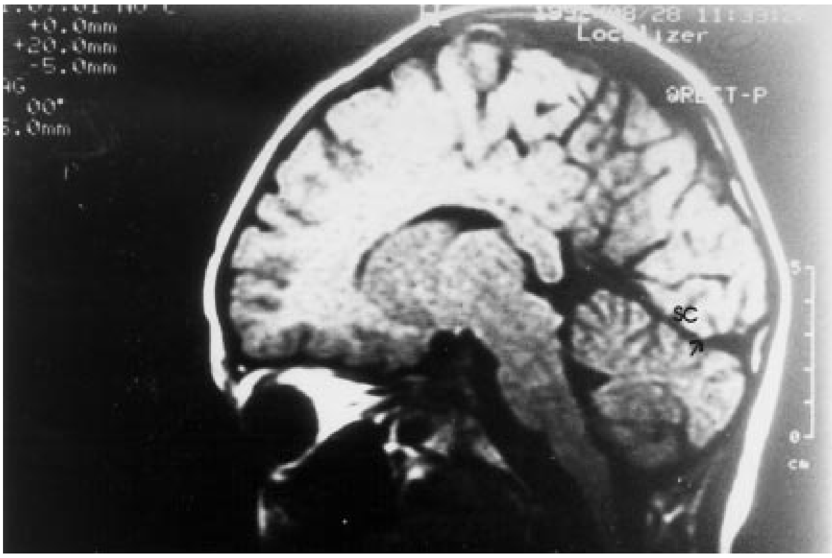

Figure 5. Conex calcarine sulcus (SC).

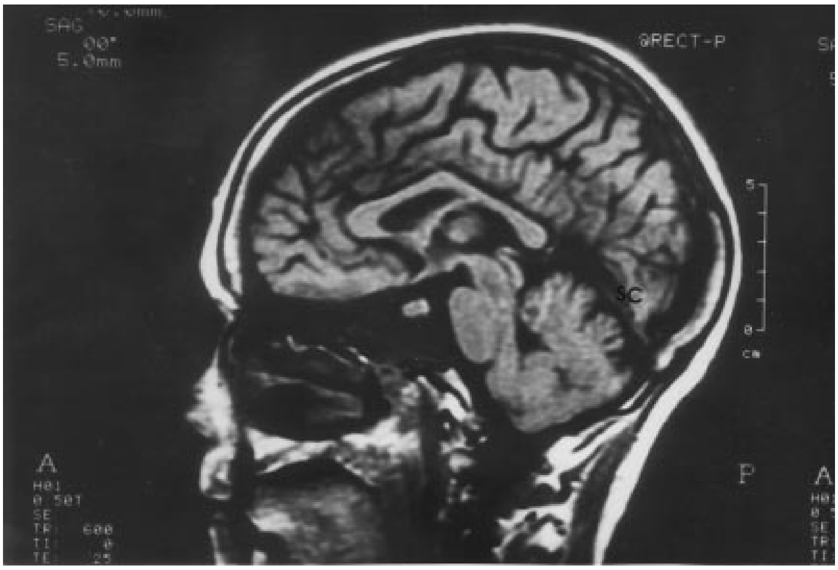

Figure 6. Angled calcarine sulcus (SC).

This study presents that the average number of the internal sulci is 5.81±1.37. This is 5.62±1.32 in females and 5.90±1.43 in males (p>0.1). Da Veiga et al found the average number of the sulci of cuneus as 5±1.5 (3). This was 5±1.5 for males and 4.7±1.4 for females (p>0.1).

Cuneus angle is described as an acute angle by Gray et al. (1). This angle is measured as 69° by da Veiga et al. (4). We measured this angle as 68.80±9.44° in females and 68.88±1.05° in males (p>0.1). The cuneus angle was 68.84±9.74 for both sexes.

Myslobodsky et al. also used magnetic resonance imaging and examined the sulcal pattern of the cuneus (4). They searched for asymmetry of the occipital lobes and found no differences for the sulcal pattern of the human cuneus.

Steinmetz et al. used MRI on 20 healthy volunteers under stereotaxic conditiones (5). They found a high sulcal variability among individuals. They concluded that macroanatomic individuality in the cerebral surface can not be accounted for adequately by proportional coordinates and that this method does not allow precise definition of anatomically based regions of interest for functional imaging. For this reason, they suggested MR mapping of the individual sulcal pattern is used to generate brain templates.

Kertesz et al. searched for anatomical and functional asymmetries on 104 right and left handed male and female adults using MRI. They found that left occipital

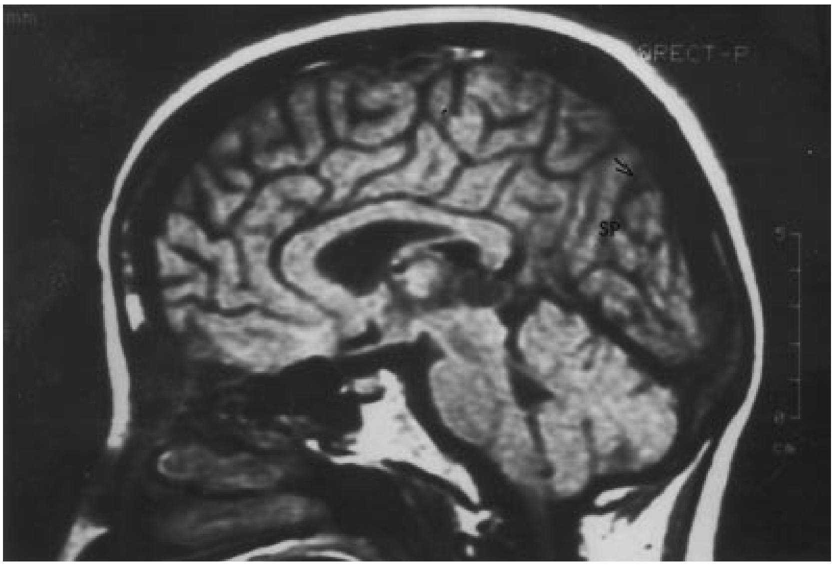

Figure 7. Bifurcation of the parieto-occipital sulcus (SP).

width was significantly largert in left dominant areas (6).

Shapiro et al. worked on CT scans of 301 patients and found that there was an equal extension of the occipital lobes in 86 patients (29%), right posterior extension in 46 patients (15%) and left occipital posterior extension in 168 patients 56%) (7).

Vannier et al. made 3D reconstructions of the brain cerebral cortical surfaces using computer software from coronal and sagittal planes to yield a setv of contiguous sections and concluded that this method is the most precise and accurate method and it has considerable potential for studies of the cortical surface of the brain (8).

Belliveua et al. used dynamic NMR imaging with a prototype high speed imaging device. The made functional mapping of the human visual cortex by a measurement of regional cerebral blood volume during resting and activated cognitive states. They concluded that quatitative imaging of cerebral blood volume is an alternative and effective technique to reflect anatomic variability (9).

Levin et al. made image processing and volume rendering using MR images and produced three-dimensional views of the surface of the brain. They concluded that this method successfully depicts abnormalities of the brain surface as well as important landmarks of normal surface anatomy (10).

References

1. Davies DV, Coupland RE. Gray's Anatomy, Longmans, London 1972, pp: 1046, 1075-76.
2. Chusid GJ, Mc Donald JJ. Correlative Neuroanatomy and Functional Neurology, Lange Medical Publications, California 1958, pp: 14-18.
3. Da Veiga M, Prates JC. The sulci of the cuneus of the human cerebrum. It J Anat Embriol 98: 41-57, 1993.
4. Myslobodsky MS, Glicksohn J, Coppola R, Weinberger D.R. Occipital lobe morphology in normal individuals assessed by magnetic resonance imaging (MRI) Vision Res 31: 1677-85, 1991.
5. Steinmetz H, Furst G, Freund HJ. Variation of perisylvian and calcarine anatomic landmarks within stereotaxic proportional coordinates AJNR 11: 1123-30, 1990.
6. Kertesz A, Polk M, Black SE, Howell J. Anatomical asymmetries and functional laterality. Brain 115: 589-605, 1992.
7. Shapiro R, Galloway SJ, Shapiro MD. Minimal asymmetry of the brain: a normal variant AJR 147: 753-756, 1985.
8. Vannier MW, Brunsden BS, Hildeboldt CF et al. Brain surface cortical sulcal lengths: quantification with three-dimensional MR imaging. Radiology 180: 479-484, 1991.
9. Belliveau JW, Kennedy DN, McKinstry RC et al. Functional mapping of the human visual cortex by magnetic resonance imaging. Science 254: 716-718, 1991.
10. Levin DN, Hu X, Tan KK, Galhotra S. Surface of the brain: three-dimensional