Topography of Sylvian Fissure and Central Sulcus as Neurosurgical Landmarks: an Anatomical Study Using Cadaveric Specimens in Iran

Mehryar Mashouf [1], Maryam Kiaee [2*], Elham Bidabadi [3]

[1] MD, International Fellow of the American Association of Neurological Surgeons (IFAANS), Rasht Arya Hospital, Guilan, Iran

[2] MD, General Practitioner, Researcher, Guilan University of Medical Sciences, Rasht, Iran

[3] MD, Associate Professor of Child Neurology, Guilan University of Medical Sciences, Rasht, Iran

*Corresponding Author Address: Takhte Jamshid Clinic, Banafshe Alley, Takhti Street, Golsar Crossroads, Rasht, Guilan, Iran. P.O.Box: 4135653917. Tel. +981333120723. E-mail: kiaee.mary@gmail.com

Article Type: Research Article

Received: February 17, 2017, Last Revised: March 7, 2017, Accepted: March 25, 2017, Published: June 30, 2017

Abstract

Background and Aim: In the present study, the cerebral surface landmarks in human fresh autopsy specimens were investigated.

Methods and Materials/Patients: Totally, 37 fresh adult autopsy human brain specimens from the Rasht Forensic Medicine Center were enrolled. Four specimens were excluded because of some traumatic injuries to cerebral cortex. Demographic information of all cases was obtained. Length of bilateral central sulcuses and posterior ramous of Sylvian fissures, thickness of superior, middle, and inferior gyri of temporal lobes, as well as the distance from frontal poles to midpoint of central sulcuses were measured and analyzed using SPSS software.

Results: In total, 25 male (75.8%) and 8 female (24.2%) specimens were included. Mean (range) length of posterior ramus of right and left Sylvian fissure were 75.61 (50-95) and 74.55 (49-100) millimeter, respectively. Mean (range) length of right and left central sulcus were 94.85 (75-115) and 97.24 (65-125) millimeter, respectively. Mean (range) thickness of right and left superior temporal gyrus were 16.66 (5-20) and 15.33 (7-25) millimeter, respectively. Mean (range) thickness of right and left middle temporal gyrus were 16.63 (5-25) and 16.42 (8-25) millimeter, respectively. Mean (range) thickness of right and left inferior temporal gyrus were 10.30 (5-20) and 10.70 (5-22) millimeter, respectively. Mean (range) distance from right and left frontal pole to midpoint of right and left central sulcuse were 81.27 (55-105) and 82.63 (60-105) millimeter, respectively. There were no statistically significant differences between two hemisphere measurements.

Conclusion: It can be said that the two hemispheres are similar in cerebral surface landmarks.

Keywords: : Anatomy; Autopsy; Cerebral Cortex; Surface Landmarks

Please cite this paper as: Mashouf M, Kiaee M, Bidabadi E. Topography of Sylvian Fissure and Central Sulcus as Neurosurgical Landmarks: an Anatomical Study Using Cadaveric Specimens in Iran. Iran J Neurosurg. 2017;3(1):27-30

Introduction

Although the wrinkles of the outermost layer of the brain vary among people and even between two right and left hemispheres, anatomical folds such as Sylvian fissure and central sulcus are more stable (the so-called anatomical landmarks) and their differences among individuals are not significant. Indeed, Sylvian fissure is the most recognizable part of the outer layer of the brain and thus Sylvian fissure and central sulcus are the main anatomical indices during brain surgery. Moreover, detailed knowledge of their size and distance from other anatomical indices such as the frontal pole, and detailed information about the distance of important locus from these markers are necessary, especially for specific surgeries such as frontal and temporal lobectomy.

Nowadays, different complex apparatuses exist for image guided surgery [1,2]. Because of setting of these systems for patients before the start of surgery, their accuracy may be decreased after skull incision and removal of CSF due to small changes in the brain position [3,4]. Thus, no assistive devices can replace the surgeon's anatomical knowledge.

Although brain wrinkles become more visible in imaging techniques such as MRI [5-14], they sometimes have inaccuracies [15-19]. Furthermore, recognizing them during surgery is very difficult due to being covered by vessels and arachnoid and small accessible space to the brain surface [20]. Therefore, the study of fixed area in wrinkles and skull surface and their anatomical relations and distances for diagnosis of other wrinkles during brain surgery are vital, as transsulcal and transfissural methods are used to reach the lesion in many of the surgeries [21,22]. Indeed, brain wrinkles are similar to hallways and corridors which guide the surgeons to the underlying lesions [23]. In the present study, the cerebral surface landmarks in human fresh autopsy specimens were investigated.

Methods and Materials/Patients

Samples

After receiving the legal license from the head of Forensic Medicine Center of Rasht, 37 fresh autopsy brains were enrolled from December 2015 to June 2016. Among them, four samples were excluded due to various reasons such as direct trauma to the brain surface. All samples were fresh and death had occurred no more than two days before.

Measurements

Some surface markers were measured using scale in millimeter at both sides. These markers included length of central sulcus from beginning near the longitudinal fissure to the end slightly above the posterior branch of the Sylvian fissure (Figure 1A), length of Sylvian fissure just at the outer surface of the brain (only the posterior branch of Sylvian fissure) from beginning in in the place of trifurcation to horizontal anterior branch, ascending anterior branch and posterior branch to the end at the temporal lobe (Figure 1B), distance of frontal pole (the most anterior area of frontal lobe in the sideview of brain hemispheres) to midpart of longitudinal fissure (Figure 1C) and thickness of upper, middle, and lower temporal gyri (Figure 1D).

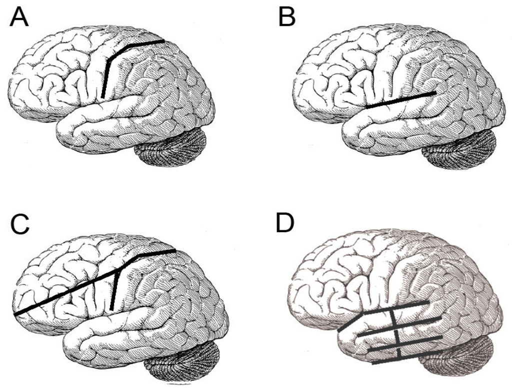

Figure 1. Schematic Presentation of Measured Markers on the Outer Surface of the Brain. A. Length of Central Sulcus; B. Length of the Posterior Branch of Sylvian Fissure; C. Distance of Frontal Pole to Midpart of Longitudinal Fissure; D. Thickness of Upper, Middle, and Lower Temporal Gyruses.

Statistical Analysis

Data were analyzed using SPSS (Version 19), length difference equal to or more than five millimeter (mm) in central sulcus, posterior branch of Sylvian fissure and distance of central sulcus to frontal pole and thickness difference equal to or more than one mm in temporal lobe gyri between right and left hemispheres were considered as significant difference.

Results

Totally, 66 hemispheres belonging to 33 cadavers, eight females (24.2%) and 25 males (75.8%) were evaluated. Mean age of the samples was 45.93 years old. The measured parameters are presented in table 1.

In this study, 13 and 11 samples (n=24, 72.8%) had longer length of Sylvian fissure in the right and left sides and nine samples showed no difference between two sides. In the central sulcus, nine and 18 samples (n=27, 81.8%) had longer length in the right and left sides and six samples had similar length in two sides. Distance of frontal pole to longitudinal fissure in 12 samples was longer in the right compared to that in the left side. This distance in 13 cases was longer in left side against right side (totally 25 samples, 75.7%). In eight samples, this distance was equal in both sides. Upper

Table 1. Measured Surface Markers of Cerebrum

Parameters (mm)	Side	Mean	Minimum	Maximum
Length				
Posterior Branch of Sylvian Fissure	Right	75.61	50	95
	Left	74.55	49	100
Central Sulcus	Right	94.85	75	115
	Left	97.24	65	125
Distance of Frontal Pole to Longitudinal Fissure	Right	81.27	55	105
	Left	82.63	60	105
Thickness				
Upper Temporal Gyrus	Right	16.66	5	20
	Left	15.33	7	25
Middle Temporal Gyrus	Right	16.63	5	25
	Left	16.42	8	25
Lower Temporal Gyrus	Right	10.30	5	20
	Left	10.70	5	22

temporal gyrus was thicker in 13 samples at right side and 16 samples at left side (n=29, 87.7%) and four samples showed no difference between two sides. About middle temporal gyrus, 10 and 13 samples (n=23, 69.6%) were thicker in the right and left sides and 10 samples had similar thickness in two sides. Finally, the thickness of lower temporal gyrus in 11 samples was greater in right compared to the left side. This thickness in 11 cases was greater in left side against the opposite side (totally 22 samples, 66.6%). In 11 samples, this thickness was equal in both sides.

Discussion

In the study of Vannier and colleagues, quantitative associations of MRI of brain cortex with real cadaver brains were evaluated [24]. But several studies were performed on the cadaver brains [25, 27-29], mostly on the formalin fixed brains. Harkey et al. evaluated five formalin fixed brains for their surface wrinkles [30]. In another study, the anatomy of middle temporal part of 26 formalin fixed brains (52 hemispheres) was studied [31] and in continuation of that work with similar authors, the areas around the Sylvian fissure in 60 formalin fixed hemispheres and 12 cadaver brains were investigated [32]. Although the study of Ribas et al. on the 16 formalin fixed brain [23] was a fully described and exact study with evaluation of several anatomical indices of brain surface, our evaluated parameters were not investigated, neither in their studies nor in the other above mentioned studies.

In the present study, difference in mean length of Sylvian sulcus between hemispheres was less than one mm (75.61 mm and 74.55 mm for right and left sides, respectively) which can be ignored. Mean of the central sulcus was 94.85 mm in the right side and 97.24 mm in the left side, which the difference was not significant. Mean distance of central sulcus to the right frontal pole was 81.27 mm and to the left frontal pole was 82.36 which was not a significant different taken together. Thickness of upper temporal gyrus in the left side was 15.33 mm and in the right side was 14.66 mm, which showed no significant difference. Mean thickness of middle gyrus of temporal lobe was 16.42 mm in the left side and 16.63 in the right side and this difference was not significant. About the lower gyrus of temporal lobe, mean thickness was 10.30 in the right side and 10.7 in the left side and this difference can be ignored. Totally, no significant differences were detected in the measured value between right and left brain hemispheres.

Funding

None

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contribution

Conception and Design: Mehryar Mashouf
Data Collection: Maryam Kiaee

Drafting the Article: Maryam Kiaee, Elham Bidabadi
Critically Revising the Article: Mehryar Mashouf, Elham Bidabadi
Reviewed Submitted Version of the Manuscript: Mehryar Mashouf, Elham Bidabadi
Approved the Final Version of the Manuscript: Mehryar Mashouf

References

1. Watanabe E, Watanabe T, Manaka S, Mayanagi Y, Takakura K. Three dimensional digitizer (neuronavigator): New equipment for computed tomography-guided stereotatic surgery. Surg Neurol. 1987; 6:543–547.
2. Sure U, Alberti O, Petermeyer M, Becker R, Bertalanffy H. Advanced image guided skull base surgery. Surg Neurol. 2000; 53:563–572.
3. Dorward NL, Alberti O, Palmer JD, Kitchen ND, Thomas DT. Accuracy of true frameless stereotaxy: In vivo measurement and laboratory phantom studies. J Neurosurg. 1999; 90:160–168.
4. Roberts DW, Hartov A, Kennedy FE, Miga MI, Aulsen KD. Intraoperative brain shift and deformation: A quantitative analysis of cortical displacement in 28 cases. Neurosurgery. 1998; 43:749–760.
5. Katada K. MR imaging of brain surface structures: surface anatomy scanning (SAS). Neuroradiology. 1990; 32(5):439-446.
6. Gong X, Fang M, Wang J, Sun J, Zhang X, Kwong WH, et al. Three-dimensional reconstruction of brain surface anatomy based on magnetic resonance imaging diffusion-weighted imaging: A new approach. Journal of Biomedical Science. 2004; 11(6):711-716.
7. Imai F, Ogura Y, Kiya N, Zhou J, Ninomiya T, Katada K, et al. Synthesized surface anatomy scanning (SSAS) for surgical planning of brain metastasis at the sensorimotor region: Initial experience with 5 patients. Acta Neurochirurgica. 1996; 138(3):290-293.
8. Zhu XD. The application of MR br ain sur face anatomy scanning in the oper ation of intr acr anial par asagittal meningiomas. Acta Chir Belg. 2008; 108(4): 420-3.
9. Gusmao S, Ribas GC, Silveira RL, Tazinaffo U. [The sulci and gyri localization of the brain superolateral surface in computed tomography and magnetic resonance imaging]. Arq Neuropsiquiatr. 2001; 59(1): 65-70.
10. Miyagi Y, Shima F, Ishido K, Araki T, Kamikaseda K. Inferior Temporal Sulcus as a Site of Corticotomy: Magnetic Resonance Imaging Analysis of Individual Sulcus Patterns. Neurosurgery. 2001; 49:1394–1398.
11. Ebeling U, Steinmetz H, Huang Y, Kahn T. Topography and identification of the inferior precentral sulcus in MR imaging. Am J Neuroradiol. 1989; 10:101–107.
12. Naidich TP, Brightbill TC. Systems for localizing fronto-parietal gyri and sulci on axial CT and MRI. Int J Neuroradiol. 1996; 2:313–338.
13. Naidich TP, Valavanis AG, Kubik S. Anatomic relationships along the low-middle convexity: Part I—Normal specimen and magnetic resonance imaging. Neurosurgery. 1995; 36:517–532.
14. Naidich TP, Valavanis AG, Kubik S, Taber KH, Yasargil MG. Anatomic relationships along the low-middle convexity: Part II—Lesion localization. Int J Neuroradiol. 1997; 3:393–409.
15. Fernandez YB, Borges G, Ramina R, Carelli EF. Double-checked preoperative localization of brain lesions. Arq Neuropsiquiatr. 2003; 61:552–554.
16. Hinck VC, Clifton GL. A precise technique for craniotomy localization using computerized tomography. J Neurosurg. 1981; 54:416–418.
17. King JS, Walker J. Precise preoperative localization of intracranial mass lesions. Neurosurgery. 1980; 6:160–163.
18. Krol G, Galicich J, Arbit E, Sze G, Amster J. Preoperative localization of intracranial lesions on MR. Am J Neuroradiol. 1988; 9:513–516.
19. Penning L. CT localization of a convexity brain tumor on the scalp. J Neurosurg. 1987; 66:474–476.
20. Kendir S, Ibrahim Acar H, Comert A, Ozdemir M, Kahilogullari G, Elhan A, Caglar Ugur H. Window anatomy for neurosurgical approaches. Laboratory investigation. J Neurosurg. 2009; 111(2): 365-70.
21. Yasargil MG, Cravens GF, Roth P. Surgical approaches to “inaccessible” brain tumors. Clin Neurosurg. 1988; 34:42–110.
22. Yasargil MG, Kasdaglis K, Jain KK, Weber HP. Anatomical observations of the subarachnoid cisterns of the brain during surgery. J Neurosurg. 1976; 44:298-302.
23. Ribas GC, Yasuda A, Ribas EC, Nishikuni K, Rodrigues AJ. Surgical anatomy of microsurgical sulcal key points. Neurosurgery. 2006; 59[Suppl 4]: 177–211.
24. Vannier MW, Brunsden BS, Hildebolt CF, Falk D, Cheverud JM, Figiel GS, et al. Brain surface cortical sulcal lengths: quantification with three-dimensional MR imaging. Radiology. 1991; 180(2): 479-84.
25. Ebeling U, Rikli D, Huber P, Reulen HJ. The coronal suture, a useful landmark in neurosurgery? Craniocerebral topography between bony landmarks on the skull and the brain. Acta Neurochir (Wien). 1987; 89:130–134.
26. Rhoton AL Jr. Cranial anatomy and surgical approaches. Neurosurgery. 2003; 53:1–746.
27. Uematsu S, Lesser R, Fisher RS, Gordon B, Hara K, Krauss GL, et al. Motor and sensory cortex in humans: Topography studied with chronic subdural stimulation. Neurosurgery. 1992; 31:59–72.
28. Brown WD. Brain: supratentorial cortical anatomy. Neuroimaging Clin N Am. 1998; 8(1): 21-36.
29. Tamura M, Ohye C, Nakazato Y. Pathological anatomy of autopsy brain with malignant glioma. Neurol Med Chir (Tokyo). 1993; 33(2): 77-80.
30. Harkey HL, al-Mefty O, Haines DE, Smith RR. The surgical anatomy of the cerebral sulci. Neurosurgery. 1989 May; 24(5):651-4.
31. Wen HT, Rhoton AL, de Oliveira E, Cardoso ACC, Tedeschi H, Baccanelli M, et al. Microsurgical anatomy of the temporal lobe: Part 1: Mesial temporal lobe anatomy and its vascular relationships as applied to amygdalohippocampectomy. Neurosurgery. 1999 September; 45(3):549.
32. Wen HT, Rhoton AL, de Oliveira E, Castro LHM, Figueiredo EG, Teixeira MJ. Microsurgical Anatomy of the Temporal Lobe: Part 2-Sylvian Fissure Region and Its Clinical Application. Neurosurgery. December 2009; 65(6):1-36

Comments

Technological progress made neurosurgery more safe and effective. Functional MRI, tractography, neuronavigation, brain stimulation and the others are important tools for a neurosurgeon, but all these resources are as nothing without a deep and comprehensive anatomical knowledge. The best way to study and learn the anatomy is specimen and anatomy lab. For this reason, this paper goes in the right direction. It might be interesting to extend this study with more surgical consideration with regard to surgery of gliomas.

Andrea Boschi, MD, Neurosurgeon, Florence, Italy