Central sulcus location

The central sulcus is a key landmark when interpreting neuroimaging as it allows for the localization of the primary motor cortex (anteriorly) and primary somatosensory cortex (posteriorly). As such, identifying the central sulcus with confidence is critical for surgical planning as well as correlating clinical symptoms with the location of pathology seen on imaging. Many techniques and signs have been described to aid the identification of the central sulcus on cross-sectional imaging. It can be argued that true localization of the primary motor cortex can only be definitively performed functionally, for example with BOLD fMRI; however, this is not available in most practices and even when available is not performed as part of routine imaging. These mostly rely on sulcal and gyral morphology and include the bracket sign, midline sulcus sign, L sign, T sign, thin postcentral gyrus sign, sigmoidal hook sign, bifid postcentral sulcus sign, M-sign, and U-sign.

Computed tomography scans of 71 adult patients with no pathological imaging were analyzed. The position of the bregma and the central sulcus was determined. The distances from bregma to the pre-central and post-central sulci were calculated. The relationships from the nasion and glabella to cortical structures were also assessed.

The mean distances between the bregma and the pre-central, central and post-central sulci were 26.8 ± 7.2; 47.8 ± 5.9 and 60.6 ± 5.7 mm, respectively, without gender discrepancy. The mean distance nasion-bregma and the nasion-related measures showed significant differences among sexes.

The central sulcus was located accurately, on average 47.8 mm behind the bregma, which should be used instead of nasion in order to avoid gender discrepancy. The data obtained provide useful and reliable information to guide neurosurgical procedures [1)].

Reduced gray-white contrast around the central sulcus is a reliable sign for identification of the central sulcus on 3D inversion recovery fast-spoiled gradient-echo images [2)].

Volume rendering of 3D FLAIR MR images shows central hypo-intensities frequently corresponding with the CS region. Two-dimensional localisation of the CS region on conventional T1-weighted images and fMRI seems favourable compared to 3D FLAIR. However, in selected cases, especially where fMRI is not possible or feasible, volume rendering with 3D FLAIR may enhance the 3D visualisation of gliomas in relation to the CS region which can be used as an alternative method in the presurgical structural and functional evaluation of neurosurgical patients [3)].

Cortical thickness measurements across the central sulcus provide a method for locating the primary motor (precentral gyri) and primary somatosensory (postcentral gyri) cortices. The higher mean cortical thickness ratio across the central sulcus corresponds with known cytoarchitectonic relationships [4)].

Central sulcus on axial imaging

Central sulcus on axial imaging.

Central sulcus on sagittal imaging

Those familiar with the typical pattern and with the common normal variations will be able to use sagittal magnetic resonance imaging to correctly localize lesions by identifying: (a) the five major rami of the sylvian fissure; (b) the subdivision of the triangular inferior frontal gyrus into the M-shaped partes orbitalis, triangularis, and opercularis by the anterior horizontal and anterior ascending rami of the sylvian fissure; © the zig-zag shape of the middle frontal gyrus, which characteristically angles sharply and inferiorly to fuse with the anterior surface of the precentral gyrus; (d) T-shaped bifurcation of the posterior end of the inferior frontal sulcus to form the inferior precentral sulcus; (e) separation of the central sulcus from the sylvian fissure by union of the opercular ends of the precentral and postcentral gyri to form the subcentral gyrus inferior to the central sulcus; (f) narrower sagittal dimension of the postcentral gyrus than the precentral gyrus; (g) horseshoe shape of the supramarginal gyrus perched atop the posterior ascending ramus of the sylvian fissure; (h) similar horseshoe shape of the angular gyrus perched atop the posterior end of the superior temporal sulcus; (i) commonly intercalated accessory presupramarginal and preangular gyri; and (j) the arcuate course of the intraparietal sulcus, which separates the superior from the inferior parietal lobules. The anatomic relationships described are more nearly constant anteriorly than posteriorly. When used as described, they prove helpful in correctly localizing pathology and in planning a surgical approach to lesions that may be difficult to localize on the basis of axial or coronal plane magnetic resonance images [5)].

Inferolateral portion

The inferolateral portion is difficult to identify if unable to trace the sulcus superoinferiorly. Su et al. observed that the cortex abutting the central sulcus appears isointense to the adjacent white matter on DWI, they named this the 'invisible cortex sign' and a study evaluated whether it could be used to identify the inferolateral central sulcus.

This observational study of 108 consecutive 'normal' MRI studies was performed from May 2016 to January 2017. A single axial DWI image - obtained in the anterior commissure-posterior commissure plane - was selected from each scan just above the subcentral gyrus such that it included the most inferolateral portion of the central sulcus. These single images were given to 10 readers (neuroradiologists, a neuroradiology fellow and radiology trainees) who marked the central sulcus based on the presence of the 'invisible cortex sign'. Their accuracy in identifying the central sulcus was compared with that of the principal investigators, who used tri-planar T1 volumetric MRI sequences.

One hundred and eight consecutive patients (55 female, 53 male) were selected, ranging from 18 to 81 years old (mean = 40.5, σ = 18.2). The central sulcus was correctly identified in 95.5% of cases (σ = 3.7%; range 89.4-99.1%).

The 'invisible cortex sign' is a highly accurate method of identifying the inferolateral central sulcus on

a single axial DWI slice without relying on the more superior aspects of the sulcus [6].

References

1)
Oberman DZ, Rasmussen J, Toscano M, Goldschmidt E, Ajler P. Computed Tomographic Localization of the Central Sulcus: A Morphometric Study in Adult Patients. Turk Neurosurg. 2018;28(6):877-881. doi: 10.5137/1019-5149.JTN.21145-17.1. PubMed PMID: 29165746.

2)
Kaneko OF, Fischbein NJ, Rosenberg J, Wintermark M, Zeineh MM. The “White Gray Sign” Identifies the Central Sulcus on 3T High-Resolution T1-Weighted Images. AJNR Am J Neuroradiol. 2017 Feb;38(2):276-280. doi: 10.3174/ajnr.A5014. Epub 2016 Dec 8. PubMed PMID: 27932507.

3)
Willemse RB, Pouwels PJ, Barkhof F, Vandertop WP. Localisation of the central sulcus region in glioma patients with three-dimensional fluid-attenuated inversion recovery and volume rendering: comparison with functional and conventional magnetic resonance. Br J Neurosurg. 2011 Apr;25(2):210-7. doi: 10.3109/02688697.2010.522742. Epub 2010 Oct 27. PubMed PMID: 20979436.

4)
Meyer JR, Roychowdhury S, Russell EJ, Callahan C, Gitelman D, Mesulam MM. Location of the central sulcus via cortical thickness of the precentral and postcentral gyri on MR. AJNR Am J Neuroradiol. 1996 Oct;17(9):1699-706. PubMed PMID: 8896626.

5)
Naidich TP, Valavanis AG, Kubik S. Anatomic relationships along the low-middle convexity: Part I–Normal specimens and magnetic resonance imaging. Neurosurgery. 1995 Mar;36(3):517-32. PubMed PMID: 7753352.

6)
Su S, Yang N, Gaillard F. Invisible cortex sign: A highly accurate feature to localize the inferolateral central sulcus. J Med Imaging Radiat Oncol. 2019 Aug;63(4):439-445. doi: 10.1111/1754-9485.12875. Epub 2019 Mar 15. PubMed PMID: 30874376.