Three-dimensional Relationship between the Corticospinal Tract and Infarcts of the Lateral Striate Arteries Territory using Tractography

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Purpose:

Patients with an infarct in the area supplied by the lateral striate arteries (LSA) often experience motor disturbance, which may indicate that the infarct involves the corticospinal tract (CST). Using a new MR imaging technique known as tractography or fiber-tracking method, we evaluated the anatomical relationship between the LSA territory and the CST, and clarified the clinical correlation between the location of infarcts and the CST.

Methods:

The study group comprised 16 patients (14 male, 2 female; age range, 28-87 years; mean age, 58.7 years) with acute or chronic infarcts in the LSA territory who received diffusion-tensor MR imaging for fiber-tracking.

Images were obtained with a whole body 1.5-T MR system (Gyroscan Intera; Philips Medical Systems) and a 6-channel phased array head coil. Diffusion-tensor imaging was performed using a single-shot echo-planar technique (repetition time [TR]=6000 ms, echo time [TE]=88 ms, and flip angle of 90˚). Diffusion-tensor MR images were obtained with a spin-echo Stejskal-Tanner sequence with 6 motion-probing gradient orientations. A b value of 800 s/mm^2 was used with averages of 6 images. The 128 x 53 data points were recorded using the parallel-imaging technique [1, 2], thus enabling image reconstruction with half the encoding steps, correspondingly reducing the geometric image distortion that is unique to echo-planar imaging. Therefore, the true resolution of the images was equivalent to 128 x 106 pixels. Thirty-six sections were obtained with a thickness of 3 mm, without intersection gaps. The field of view was 230 mm. The total time for diffusion-tensor MR imaging for fiber tracking was 4 minutes 24 seconds.

Diffusion-tensor MR imaging data were transferred to an offline workstation for analysis. Diffusion-tensor elements and anisotropy at each voxel were calculated, and color maps were created from these data. Translation of the vectors into neuronal trajectories was achieved by means of postprocessing of diffusion-tensor data using the method previously described [3]. To map the neural connections, two arbitrary regions of interest (ROIs) in the 3-dimensional space were designated. Tracking was terminated (stop criterion) when it reached a pixel with low fractional anisotropy (FA) and/or a predetermined trajectory curvature between two contiguous vectors. Fiber tracts that pass through both ROIs were designated the final tract of interest, namely the CST.

To assess the relationship between the symptoms and the location of the infarct, we divided the LSA territory into the anterior and the posterior segments, according to the previous research [4-6]. The coronal plane that crosses through the foramen of Monro was selected as the boundary between anterior/posterior segments. In addition, to further specify where the CST crosses infarcts of LSA territory, each of the two segments was divided into two subsegments by the axial plane that crosses through the foramen of Monro. Thus, the LSA territory was finally separated into four subsegments: the anterosuperior, the anteroinferior, the posterosuperior, and the posteroinferior segments.

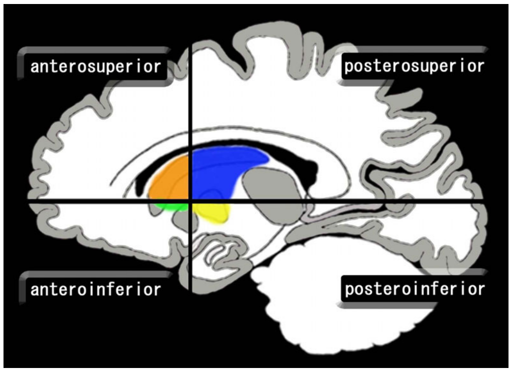
Results:

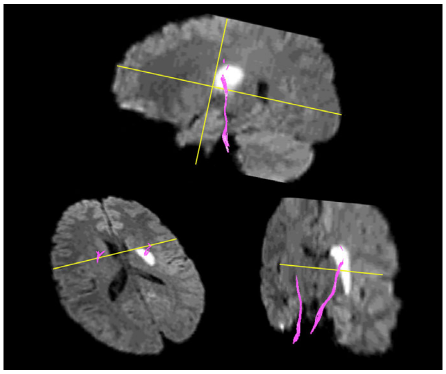
MR images, including diffusion-weighted images, were successfully obtained in all patients. The CST was also successfully visualized bilaterally in each patient using tractography.

The infarct in this study was present in either the anterior or the posterior segments of the LSA territory but not at both areas. All lesions in acute infarct patients were located in the posterior segment, while all of chronic infarcts were present in the anterior segment. The CST was found to cross the LSA territory only at the posterosuperior segment. All infarcts that were found in the posterosuperior segment not only had involvement of the CST, but also had severe motor symptoms.

Conclusion:

This study provides new and important information on the clinical and anatomical relationship between the CST and infarcts in the LSA territory. We believe this relationship will provide valuable information that will assist outcome prediction in stroke patients.





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