Somatotopic Organization of Motor Fibers in the Corona Radiata in Monoparetic Patients With Small Subcortical Infarct

Young-Mok Song, MD

**Background and Purpose**—The somatotopic organization of the corticospinal fibers is of importance because it is related to certain stroke syndromes. Although it has been suggested that motor fibers are somatotopically arranged in the corona radiata, the evidence is still insufficient in human.

**Methods**—The relative anteroposterior and mediolateral location of the lesions was measured on T2-weighted MRI in 28 patients who developed isolated motor deficit limited to the arm, leg, or bulbofacial muscles after a small corona radiata infarct. The location of the lesions associated with bulbofacial, arm, and leg paresis showed anterolateral-to-posteromedial distribution.

**Results**—The results suggest that motor fibers subserving the bulbofacial, arm, and leg muscles are somatotopically arranged at the level of the corona radiata. (*Stroke. 2007;38:2353-2355.*)

**Key Words:** corona radiata □ infarct □ monoparesis □ somatotopy

The somatotopic organization of the corticospinal system is important because it is related to certain stroke syndromes. It has been suggested that the descending motor fibers emerging from the cortical motor strip maintain the somatotopic arrangement in the corona radiata. However, the data are still insufficient in human. Although a few studies reported the presence of somatotopy in the corona radiata in patients with a small subcortical infarct, the patients’ motor deficits were not confined to a single part of the body, which obscured the precise topographic association of the lesion with a specific body part. Moreover, the topographic distribution was investigated only in the anterior-to-posterior direction although the motor cortex is somatotopically arranged in the medial-to-lateral direction.

The author assessed the anteroposterior and mediolateral topography of the lesions in patients with isolated arm, leg, bulbar, or bulbofacial weakness, so called monoparesis in a broad sense caused by a small subcortical infarct to investigate more definite somatotopic organization of motor fibers in the corona radiata.

**Materials and Methods**

The author studied the consecutive 28 patients who developed isolated monoparesis after an acute infarct in the corona radiata, selected from all patients who were admitted to Dankook University Hospital because of a first-ever stroke between February 2000 and July 2006. The inclusion criteria were (1) isolated arm, leg, bulbar, or bulbofacial paresis, (2) absence of any sensory disturbance or significant ataxia, and (3) the lesion was less than 2 cm in size and the location of it was restricted to the corona radiata adjacent to the lateral ventricle without involving the internal capsule. A corona radiata lesion partially extending into the basal ganglia was included.

All patients underwent brain MRI including T2-weighted image (T2WI, 1.5T, TR, 5000 ms; TE, 80 ms) and diffusion-weighted image (DWI, b=1000 s/mm²; TR, 6000 ms; TE, 84 ms), and MR angiogram covering the cerebral and carotid arteries within 3 days after admission. The acute lesion responsible for the patient’s weakness was identified using DWI. The lesion size was measured as the longest diameter of the lesion on T2WI. The anteroposterior and mediolateral localization of the lesion was assessed at the level of the corona radiata showing the insula cortex and the lateral ventricle on T2WI. The longitudinal distance between the most lateral points of the anterior and posterior horns of the lateral ventricle (AP), and that between the center of the lesion and the most lateral point of the posterior horn of the lateral ventricle (LP) were measured (Figure, A). The anteriority index was defined as the LP/AP ratio and used to assess the anteroposterior localization of the lesions. The horizontal distance between the gray matter margin of the insula cortex and the wall of the lateral ventricle (IV), and that between the center of the lesion and the wall of the lateral ventricle (LV) were measured (Figure, A). The mediolateral localization of the lesions was assessed using the laterality index that was defined as the IV/LV ratio.

Statistical analysis was performed using the ANOVA and student *t* tests for continuous variables and the *χ²* test for dichotomized variables.

**Results**

There were 20 men and 8 women with a mean age of 62±10 (SD) years. Twenty-five patients were admitted within 2 days...
of stroke onset and 3 patients between 3 and 5 days after onset. The risk factors were hypertension in 22, diabetes mellitus in 8, hypercholesterolemia in 3, current smoking in 8, and atrial fibrillation in 2 patients. Two patients had mild stenosis in the ipsilesional middle cerebral artery.

Fourteen patients had isolated bulbofacial paresis (8 had pure dysarthria and 6 had dysarthria with facial palsy), 8 had arm monoparesis, and 6 had leg monoparesis. The lesion side (right side in 14 and left side in 14 patients) and lesion size (mean 9.3±3.7 mm) were not different between patients with different motor deficit types (Table).

The acute lesions responsible for the motor deficit could be identified in all patients on DWI and T2WI. The distribution of the lesion location represented by the anteriority and laterality index is displayed in Figure B. The anteriority and laterality index differed among the lesions causing different type of motor deficits (Table). The anteriority index of the lesions with bulbofacial paresis was higher than that of the lesions with arm paresis ($P<0.01$, respectively), which had higher anteriority index than those with leg paresis ($P<0.01$). The laterality index was highest in the lesions with bulbofacial paresis followed by arm paresis and leg paresis. Although it was significantly higher in the lesions with bulbofacial or arm paresis than in those with leg paresis ($P<0.01$, respectively), the difference was not significant when the lesions with bulbofacial or isolated bulbar paresis were compared with those with arm paresis ($P=0.57$ and $P=0.38$, respectively).

**Discussion**

The patients included in the study had isolated monoparesis, which might produce more reliable results regarding the lesion topography in relation to the specific body part. I did not divide the patients with pure dysarthria from those with dysarthria with facial palsy in the analysis because the 2 groups had the common motor deficit of dysarthria and did not significantly differ with respect to the lesion characteristics.

The data suggest that motor fibers for the bulbofacial-arm-leg muscles are arranged anterolateral-to-posteromedially in the corona radiata. Although the anteroposterior somatotopy for these body parts has been reported in the previous studies, the mediolateral topographic distribution is first demonstrated in this study. The mediolateral somatotopy of motor fibers in the corona radiata may arise from the mediolateral distribution of the leg, arm, and bulbofacial areas in the corona radiata.

**Characteristics of the Lesions Associated With Different Type of Motor Deficit**

<table>
<thead>
<tr>
<th></th>
<th>Bulbofacial Paresis (n=14)</th>
<th>Arm Monoparesis (n=8)</th>
<th>Leg Monoparesis (n=6)</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesion side (right), n</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>0.84</td>
</tr>
<tr>
<td>Lesion size, mm</td>
<td>9.1±4.5</td>
<td>9.3±3.1</td>
<td>9.5±3.2</td>
<td>0.98</td>
</tr>
<tr>
<td>Anteriority index</td>
<td>0.49±0.05</td>
<td>0.40±0.05</td>
<td>0.30±0.06</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Laterality index</td>
<td>0.68±0.10</td>
<td>0.66±0.06</td>
<td>0.50±0.07</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
motor cortex. However, the lesions with bulbofacial or isolated bulbar deficit were not located significantly more laterally than those with arm deficit, which reflects very close location of the bulbar, facial, and arm fibers in the mediolateral direction at the level of the corona radiata. The mean anteriority index of the 3 groups was all lower than 0.5, indicating that most of motor fibers descend in the posterior portion of the corona radiata as in the internal capsule.

In the present study, the easily recognizable structures adjacent to the corona radiata were used as the landmark for the boundary because the anatomic margin of the corona radiata could not be directly defined on T2WI. Individual variation in the shape and level of the lateral ventricle and the insula cortex may also influence the results. However, such factors would not result in significant deviation of a particular group of data.

In conclusion, the present study suggests that motor fibers subserving the bulbofacial-arm-leg movement are arranged anterolateral-to-posteromedially in the corona radiata.

Disclosures

The present research was conducted by the research fund of Dankook University in 2006.

References

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