Motor Function Recovery in Stroke Patients with Corona Radiata Infarct: 4 Case Studies

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Purpose: The aim of this study was to use fMRI and clinical prognosis criteria to evaluate therapeutic interventions in stroke patients with corona radiata infarct and acquire fundamental information about recovery mechanisms.

Methods: Four subjects (2 men, 2 women) who had strokes with corona radiata infarct were recruited. For all subjects, motor functions such as motricity index (MI), modified brunnstrom classification (MBC), functional ambulatory category (FAC), and bathel index (BI) were evaluated. Evaluations were done at least 4 times over a period of approximately 6~7 months from stroke onset. We compared the final evaluation with the first.

Results: All patients with corona radiata infarct showed improvement in motor outcomes with the passing of time. The strength of all patients improved from zero or trace levels to normal or good levels in the MI (Motricity Index) test. Other motor outcomes including the modified brunnstrom classification (MBC), the functional ambulatory category (FAC), and the bathel index (BI) also improved with the passing of time.

Conclusion: Stroke patients with corona radiata infarcts change for the better over time. Therefore, one can introduce clinical interventions by the aspect of progress in functional motor recovery.

Keywords: Corona radiata infarct, Motor recovery, Brain plasticity, Functional MRI, Stroke

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I. Introduction

Stroke can cause major motor dysfunction that lowers the ability to perform varied activities. Impaired motor function is one of the most serious disabling sequela of stroke, with over the 50% of stroke patients experiencing with a residual motor deficit.[1] Motor deficits are found in over the 80% of these patients leading to disability such as muscle weekness, abnormal movement pattern, irregular muscle tone and declined motor control.[2,3] Clarification of the motor recovery mechanism in stroke patients is really important because such information could provide the scientific basis for stroke rehabilitation, which is anticipated to be focused on aspects of brain plasticity in the near future.[4] Many previous studies have revealed that there is a difference among patients in terms of their extent of motor recovery, but generally they are recovered of itself within 3 months and the appearance of motor recovery is varible.[5-7]

The corona radiata infarcts are of the most common strokes of lacunar syndrome, which result in a varying extent of pure motor syndrome.[8,9] It has a wide clinical spectrum including incomplete motor and sensory distribution patterns in the unilateral infarct, and additional neuropsycological deficits in multiple and bilateral infarct.[10] Futhermore, the clinical pictures and recovery patterns have been reported.[9,11-13] Shelton et al.[14] revealed that 75% of the patients with cortical infarct showed isolated movement recovery of upper extremity although only 5.9% of patients with corona radiata infarct did. Accordingly, among the several regions through which the corticospinal tract passes, the corona radiata is the most important because it is an area that is commonly affected by stroke, and its involvement is related to poor motor outcome in stroke patients.

For elucidating the motor recovery mechanism, a variety of

neuroimaging techniques have been used such as diffusion tensor image tractography (DTI), transcranial magnetic stimulation (TMS), functional magnetic resonance imaging (fMRI), and so forth, which are useful for quantitatively evaluating the extent of motor recovery.[15,16] Since corticospinal tract is located in the posterior portion of the corona radiata, recovery of the corticospinal tract in the corona radiata infarct seems to be meaningful in predicting the motor outcome of the affected side. Kwon et al.[17] reported that motor recovery through DTI in the patients with corona radiata infarct reflects functional reorganization of the motor pathway depending on the damage to the corticospinal tract. Jang et al.[18] revealed that motor function of the affected upper extremity in the corona radiata infact is recovered through a process of brain plasticity.

In the study of the motor recovery mechanism, fMRI technology is the powerful way to unveil the underlying recovery mechanism at the subcortical level in stroke patients. Many efforts have been made to elucidate the motor recovery mechanisms, but these mechanisms have not yet been clearly elucidated. Therefore, we report the case study of the stroke patients with corona rediata infact whose motor function appeared to be recovered and it presented fundamental information about the recovery mechanism by using fMRI.

II. Methods

1. Subjects and Methods

Four subjects (men: 2, wemen: 2) who were diagnosed as stroke with corona radiata infarct were recruited in this case study. All subjects understood the purpose of the study and provided formal consents prior to participation. The included criterion was no pathology of musculoskeletal function and was estimated Korean mini-mental state examination (K-MMSE) in stroke onset. Evaluations were done at least 4 times over a period of approximately 6~7 months from stroke onset (Table 1). In all subjects, the motor function such as motricity index (MI), modified brunnstrom classification (MBC), functional ambulatory category (FAC), and bathel index (BI) were evaluated.

2. Clinical evaluations

Motor function of the affected extremity was measured 4 times and we compared the final evaluation (after 6~7 months from onset) with the first (at stroke onset). The standardized MI was employed to determine muscle strengh. MI is a measure of the integrity of motor function with the maximum score of 100. The reliability and validity of the MI are well established.[19] The function of the affected hand was categorized according to MBC: there are six categories (1~6).[20] The ambulatory ability was determined by the standardized FAC: scoring is designed to examine the levels of required assistance during a 15 m walk.[21] There are six categories (1~6) and the reliability and the reliability, validity are well established.[21] The quality of life was determined by BI which is a measure of the activities of daily living (ADL).[22] There are ten subtest categories included and each category is rated 0, 5 or 10 (or 15 for two of the test categories). Maximum total score is 100. The reliability and validity of the BI is well established.[23]

3. Case descriptions

Patient A: A 84 years old eldly woman, left hemiparesis, whose occurred in January, 2006, was recruited and diagnosed as right corona radiata infarct by using MRI (Figure 1-A). Patent B: A 73 years old eldly woman, right hemiparesis, whose infarct occurred in November, 2006,was recruited and diagnosed as left corona radiata infarct by using MRI (Figure 1-B). Patent C: A 71 years old eldly man, right hemiparesis, whose infarct occurred in October, 2007, was recruited and diagnosed as left corona radiata infarct by using MRI (Figure 1-C). Patent D: A 64 years old eldly woman, left hemiparesis, whose infarct occurred in October, 2007, was recruited and diagnosed as right corona radiata infarct by using MRI (Figure 1-D).

Table 1. General characteristic of each subject

Case	Age (yrs)	Gender (M/F)	Stroke type	Affected hemisphere	Time since onset (mth)	Range (mth)	MMSE (score)
A	84	F	CR infarct	Rt	1	6	27
B	73	F	CR Infarct	Lt	1	7	29
C	71	M	CR Infarct	Lt	1	6	15
D	64	F	CR infarct	Rt	1	7	28

CR: Corona radiata, MMSE: Mini-mental state examination

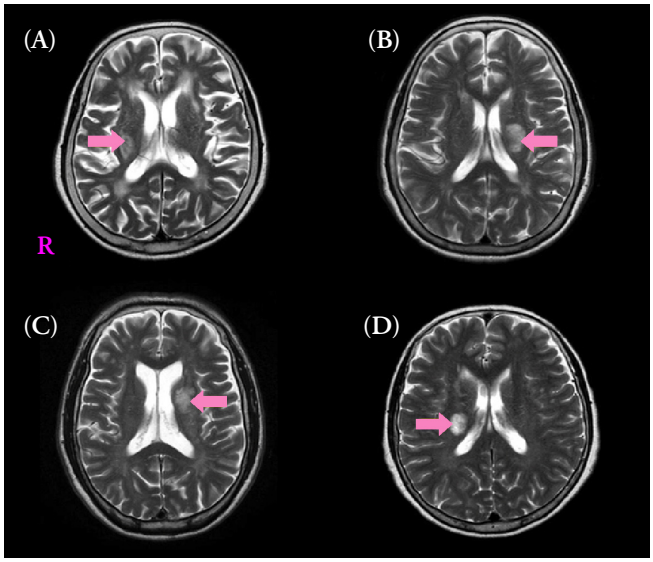

Figure 1. T2-weighted image of each subject at corona radiata lesion.

III. Results

1. Functional change of motor recovery

As time passed, the patient A showed that muscle strengh was significantly improved from the first assessment to the last assessment: MI scores of upper extremity increased from 0 to 56 and lower extremity's scores increased from 42 to 74. Over time, the MBC scores also increased from 2 to 3 comparing the assessment at stroke onset with at the final. In the assessment of ambulatory ability and quality of life, this patient showed improvements with the passing of time: ie, FAC scores increased from 0 to 3, BI scores increased from 55 to 72 comparing the first assessment with the final (Table 2).

As time passed, the patient B showed that muscle strengh was significantly improved from the first assessment to the last assessment: MI scores of upper extremity increased from 0 to 84 and lower extremity's scores increased from 0 to 100. Over time, the MBC scores also increased from 1 to 6 comparing the assessment at stroke onset with at the final. In the assessment of ambulatory ability and quality of life, this patient showed improvements with the passing of time: ie, FAC scores increased from 0 to 3, BI scores increased from 44 to 88 comparing the assessment at stroke onset with at the final (Table 2).

As time passed, the patient C showed that muscle strengh was significantly improved from the first assessment to the last assessment: MI scores of upper extremity increased from 59 to 100 and lower extremity's scores increased from 56 to 91. Over time, the MBC scores also increased from 3 to 5 comparing the assessment at stroke onset with at the final. In the assessment of ambulatory ability and quality of life, this patient showed improvements with the passing of time: ie, FAC scores increased from 1 to 4, BI scores increased from 32 to 66 comparing the assessment at stroke onset with at the final (Table 2).

As time passed, the patient D showed that muscle strengh was significantly improved from the first assessment to the last assessment: MI scores of upper extremity increased from 48 to 100 and lower extremity's scores increased from 47 to 83. Over time, the MBC scores also increased from 1 to 6 comparing the assessment at stroke onset with at the final. In the assessment of ambulatory ability and quality of life, this patient showed improvements with the passing of time: ie, FAC scores increased from 1 to 3, BI scores increased from 51 to 84 comparing the assessment at stroke onset with at the final (Table 2).

IV. Discussion

In the current study, we tried to know the pattern of motor recovery in the patients with corona radiata infarct through the evaluation of motor functions such as MI, MBC, FAC and BI during 6~7 months. According to the results, we found that all patients showed improvements with the passing of time in motor function: ie, scores of each motor evaluation increased

Table 2. Results of motor functional evaluations according to recovery period

Case	Upper MI		Lower MI		MBC		FAC		BI	
	initial	final	initial	final	initial	final	initial	final	initial	final
A	0	56	42	74	2	3	0	3	55	72
B	0	84	0	100	1	6	0	3	44	88
C	59	100	56	91	3	5	1	4	32	66
D	48	100	47	83	1	6	1	3	51	84

Unit: Score, MI: Motricity Index, MBC: Modified Brunnstrom Classification, FAC: Functional Ambulatory Category, BI: Bathel index

more than initial evaluation. These results would imply that patterns of motor recovery in patient with corona radiata infarct change for the better over time.

In the initial evaluation after stroke onset, all patients presented severe weakness of the affected extremity, and their motor function is recovered slowly to the point of being nearly normal. This strongly proposes that the motor function of the affected extremity is recovered through a process of brain plasticity.[24] Accordingly, the motor function of the affected extremity recovered via a motor pathway that passes through the surrounded portion of the infarcted corona radiata. Also, many previous studies have reported that corticospinal tract is located in the corona radiata and plays an important role in motor recovery in stroke patients.[11,25,26] Jang et al.[18] demonstrated that the motor function of the affected hand was reorganized to the posterior portion of the infarcted corona radiata using DTT and fMRI. Song[27] revealed that motor fibers subserving the bulbofacial, arm, and leg muscles are somatotopically arranged at the level of the corona radiata using fMRI. Similarly, in the current study, all patients showed that motor function of the affected extremity is improved through the reorganization of neural pathway associated with motor recovery in process of time. In brief, motor recovery mechanism of corona radiata infarct is closely associated with corticospinal tract in the region around lesion.[17,18] Generally, the prognosis of motor function is good because of the facilitation of motor recovery provided by external information and caused by automatic brain plasticity in process of time.

The motor recovery mechanism for the stroke patients is elucidated by the evaluation of long-term clinical symptom, variable patterns of recovery and extent of residual motor function rather than the evaluation of short-term.[6,15,28] According to previous studies supporting the motor recovery of corona radiata infarct, the various clinical patterns depending on involved region of infarct were showed.[10,13,25] Moreover, the integrity of the corticospinal tract obtained during the early stage of a corona radiata infarct seems to be helpful in predicting the motor outcome of the affected extremity and in expecting the extent of motor recovery for motor function.[11] However, we have evaluated by using detailed methods and showed a series of recovery process through the long-term study of specific patient.

We acknowledge that this study has limitations. For example, a small number of patients were involved. Therefore, further studies will be required to ascertain the detailed mechanisms of the motor recovery for corona radiata infarct, taking these additional factors into consideration and involving larger case numbers.

V. Conclusion

The scientific basis for stroke rehabilitation can be established when the detailed mechanisms of recovery are clarified. However, motor recovery of corona radiata has not yet been clearly elucidated, even in terms of the recovery mechanism following the long-term. Therefore we suggest that aspects of functional recovery and clinical prognosis are clearly predictable for specific patients with corona radiata infarct. In addition, adequate therapeutic interventions can provide patients with clinical criterion through aspects of functional recovery.

Author Contributions

Research design: Kim CS
Acquisition of data: Kwon JW
Analysis and interpretation of data: Kwon JW
Drafting of the manuscript: Kwon JW, Kim CS
Research supervision: Kim CS

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