Patients' characteristics and outcomes depending on complete or incomplete unilateral spatial neglect

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Abstract

Unilateral spatial neglect (USN) is known to depress the activities of daily living. The purpose of this study was to clarify that categorizing the type of USN using line cancelation and line bisection tests is important when evaluating patients with acute intracerebral hemorrhage (ICH). In this study, patients with ICH were prospectively evaluated for the presence of USN using line cancelation and line bisection tests. They were classified into an incomplete USN group (iUSN = abnormal results in either test) or a complete USN group (cUSN = abnormal findings in both tests). We compared the initial severity of ICH and the outcomes of USN in the two groups. We were able to assess 16 patients, among whom 10 showed USN. Seven were then categorized as having iUSN and three as having cUSN. The median hematoma volume was larger in the cUSN group than in the iUSN group. The USN symptoms of patients in the iUSN group disappeared during the chronic phase, whereas the symptoms of patients in the cUSN group continued. The type of USN was associated with the initial severity of ICH and the persistence of USN.

Keywords Cerebral hemorrhage, acute • Unilateral spatial neglect • Rehabilitation • Outcome • Line cancelation • Line bisection

Introduction

Unilateral spatial neglect (USN) is a symptom defined as failure to report, respond, or orient to contralateral stimuli that is not caused by an elemental sensorimotor deficit. Although little is known about whether the frequency of USN associated with hemorrhagic stroke is higher or lower than that with ischemic stroke, the age and sex of the patient and the site and size of the lesion may influence the frequency of USN [1]. USN was demonstrated in 81.3 % of patients with right intracerebral hemorrhage (ICH) in the subacute phase and was associated with diminished activities of daily living (ADL) during the chronic phase [2-4].

Because of the disturbed consciousness and change in neurologic function, evaluation of USN is difficult in the acute setting. In many studies, assessment for USN was conducted about 1 month after the onset of stroke. Earlier evaluation may be helpful to predict the presence of USN at discharge and the total length of hospital stay [5]. We conjectured that simple evaluation using line cancelation and line bisection tests would be meaningful for assessing patients with acute ICH. Importantly, it has not been determined whether the severity of USN during the acute phase of stroke could predict the severity of USN during the chronic phase. We hypothesized that the line cancelation and line bisection tests could be used to confirm the presence of USN and that these simple evaluations could identify an association between the initial severity of ICH and the persistence of USN.

Materials and methods

Patients with putaminal or thalamic hemorrhage being treated at the Department of Neurosurgery, Fukuoka University Hospital, Japan, were registered prospectively from May 2012 to April 2014 to evaluate USN. Beginning from the start of their evaluation, the total term of this study was May 2012 to April 2014. We intended for this observational prospective study to last longer, but we had to cease registering patients in April 2014 because of a shortage of speech therapists (STs). We included patients with both right- and left-sided hemorrhagic stroke. Patients were excluded if they experienced consciousness disturbance, aphasia, or significant visual disorder that interfered with their ability to perform the USN evaluation. We did not exclude patients with motor deficits because the method of evaluating USN was so easy that they could be checked using the non-affected hand. The ethics committee of Fukuoka University Hospital

approved this study. Written informed consent was obtained from all patients or their families.

A speech therapist (J.W.) evaluated USN using the line cancelation and line bisection tests. The protocol for these tests has been described previously [2]. The patients were diagnosed to have USN depending on whether they identified that more than 70 % of uncrossed lines were on the same side as the brain lesion (line cancelation test) or the marked point deviated more than 12.75 mm of the midpoint on the 204-mm line (line bisection test). USN was confirmed based on the abnormality of either test. Patients with abnormal results in either test were categorized as having incomplete USN (iUSN), and those with abnormal findings in both tests were determined to have complete USN (cUSN).

Patients' characteristics, region volume, and location of the hematoma as evaluated by initial computed tomography (CT) were recorded at admission. The neurologic symptoms were evaluated at the time of the USN examination. All study patients were moved to a convalescence-stage hospital for further rehabilitation. The duration of hospital stay and the presence or absence of USN at discharge were determined by checking the clinical reports from the convalescence hospitals. USN at discharge from a convalescence hospital was determined based on the Behavioral Inattention Test and/or the Catherin Bergego scale [6].

Statistical analysis

Patients' background and hematoma characteristics were compared between the iUSN and cUSN groups. The data of the patients gathered before leaving our hospital were their age, sex, co-morbidities (hypertension, diabetes mellitus, smoking, drinking); the affected side, site, and volume of the hematoma; Glasgow Coma Scale score; presence of aphasia, paralysis, visual disorder; National Institutes of Health Stroke Scale/Score; operation. The data collected before their leaving the convalescence hospital were the presence of USN, total hospital stay, and modified Rankin Scale score. The frequency of USN persistence and total hospital stay at the convalescence-stage hospital were compared between groups.

Statistical significance of continuous variables was assessed using either parametric or nonparametric tests, depending on whether the values were normally distributed (analyzed with the Shapiro–Wilk test). Fisher's exact test was conducted to

assess the categorical variables. A value of $p < 0.05$ was considered to indicate statistical significance. Data were analyzed using SPSS Version 22.0 (IBM Corp., Armonk, NY, USA).

Results

Among the 40 patients who had either putaminal or thalamic hemorrhage, examination for USN was incomplete in 24 because of disturbed consciousness (*n*=16), severe attentional problem or aphasia (*n*=5), visual disability (*n*=2), or delirium (*n*=1) (Fig. 1). The patients were assessed for USN at a median of 5 days from onset. USN was deemed present in 10 patients. Thus, the 10 patients comprised the study group. The data from all of them were complete. Seven were categorized as belonging in the iUSN group, and three were deemed appropriate for the cUSN group (Table 1). No differences in the frequency of USN were observed between right- and left-sided hemorrhage. Nor did the frequency of a visual disorder differ between those with cUSN and iUSN.

The median hematoma volume was 61.8 mL in the cUSN group, which was significantly greater than that in the iUSN group (10.2 mL) ($p = 0.017$, Mann–Whitney U test). Patients in the cUSN group were evaluated on day 15, whereas the median day of evaluation for the iUSN group was day 4 ($p = 0.057$, Mann–Whitney U test). Significantly more severe neurologic symptoms were seen in more patients in the cUSN group than in the iUSN group. Total hospital stay tended to be longer for the cUSN group than the iUSN group. Whereas USN resolved in the iUSN group before discharge from the convalescence hospital, it continued after discharge in the cUSN group.

Discussion

The hypothesis of this study was that the type of USN portended the initial severity of ICH and the persistence of USN. We showed that the type of USN was significantly associated with not only the characteristics of ICH but also the outcome of the USN patients at discharge, proving our hypothesis.

Because USN sometimes constrains stroke patients from undergoing rehabilitation or living at home, it is important to predict whether USN remains in the chronic phase. Although there are many tests for USN that could provide a more precise diagnosis, neurologic complications such as confusion, aphasia, apraxia, or paralysis frequently interfere with the evaluation of USN. Maeshima et al. [2] reported that transient or

permanent USN was associated with the quantity of hematoma at admission and with the Barthel index at discharge [1]. We proposed the utility of simple evaluations of USN (line cancelation and line bisection tests), which showed significant association with the characteristics in the acute stage and the outcome in the chronic stage. One of the advantages of the method used in our study was its simplicity, which enabled us to predict accurately the patients who would have persistent USN. This simple categorization of iUSN and cUSN may predict the severity of the hematoma and the outcome of USN in patients with ICH.

This study also indicated that the frequency of USN in the acute stage was not significantly different between right- and left-sided hemorrhages, but there was a difference depending on the volume of the hematoma. One possible explanation is that deep nuclei and periventricular fibers are associated with the recognition of space through the cortico-cortical fiber pathway, so USN can be easily seen in the deep brain lesion [2].

There are some limitations in this study. First, the sample size was small, thereby making the numbers of patients in each group small. Thus, a multiple regression analysis could not be performed. Second, the hematoma volume was definitively larger in patients with cUSN than in those with iUSN. Thus, it is possible that hematoma volume, rather than USN type, was the main factor associated with USN persistence. Third, the patients with iUSN might have had cUSN at admission. The timing of the evaluation might have affected the results. Further studies are needed to evaluate this point. Fourth, we diagnosed USN using the Behavioral Inattention Test and/or the Catherin Bergego scale during the chronic phase. The Behavioral Inattention Test is used for the clinical and objective diagnosis of USN, whereas the Catherine Bergego evaluates the impact of USN on activities of daily living. However, it was left to the convalescence hospital whether to use one or the other test, and thus we were unable to analyze those scores. Another limitation was that the methods for evaluating line bisection and cancellation differ greatly from the methods used in the Behavioral Inattention Test or Catherin Bergego scale during the chronic phase. We did, however, demonstrate the usefulness of these simple methods for evaluating USN in the acute setting.

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Conflicts of interest

The authors declare that they have no conflict of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in this study.

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214 unilateral spatial neglect
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	complete (n=3)	Incomplete (n=7)	P value	DF
Age	59.7±15.3	67.1±8.4	0.33*	8.0
Sex (female)	3 (100%)	3 (42.9%)	0.20	
Hypertension	3 (100%)	6 (85.7%)	1.00	
Diabetes mellitus	0 (0%)	3 (42.9%)	0.48	
Smoking	0 (0%)	0 (0%)		
Drinking	0 (0%)	3 (42.9%)	0.48	
Side (right)	2 (66.7%)	4 (57.1%)	1.00	
Site of hematoma	thalamus 0 putamen 3	thalamus 5 putamen 2	0.17	
Volume of hematoma (ml)	61.8 (55.0-90.0)	10.2 (4.8-14.5)	0.017**	
GCS	10 (9-11)	15 (14-15)	0.017**	
Aphasia	1 (33.3%)	1 (14.3%)	1.00	
Paralysis	3 (100%)	6 (85.7%)	1.00	
Visual disorder	1 (33.3%)	1 (14.3%)	1.00	
NIHSS	20 (18-25)	11 (10-14)	0.033**	
Operation	3 (100%)	2 (28.6%)	0.17	
USN at discharge	3 (100%)	0 (0%)	0.008	
Total hospital stay (days)	232±69	134±67	0.068*	8.0
Modified Rankin Scale	4 (4-4)	3 (2-4)	0.12*	

The F and P value of Levene's test on age was 2.6 and 0.15 respectively.
The F and P value of Levene's test on total hospital staying was 0.01 and 0.92.
*Unpaired t-test, **Mann–Whitney U-test. NIHSS; National Institute of Health and Stroke Scale, GCS; Glasgow Coma Scale. DF; degree of freedom

Figure legend

Fig. 1 Patient enrollment for analysis based on the presence and types of unilateral spatial neglect