Neuropsychological Factors Related to Returning to Work in Patients with Higher Brain Dysfunction

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Abstract: We conducted neuropsychological tests of patients with higher brain dysfunction to examine the characteristics of barriers to employment. Subjects and Methods: We tested 92 patients with higher brain dysfunction (average age of 36.3 ± 13.8 years old, ranging between 16 and 63 years old, with an average post-injury period of 35.6 ± 67.8 months) who were hospitalized at the university hospital between February 2002 and June 2007 for further neuropsychological evaluation, conducting the Wechsler Adult Intelligence Scale-Revised (WAIS-R), Wechsler Memory Scale-Revised (WMS-R), the Rivermead Behavioral Memory Test (RBMT), Frontal Assessment Battery (FAB) and Behavioral Assessment of Dysexecutive Syndrome (BADS). The outcomes after discharge were classified between competitive employment, sheltered employment and non-employment, and the three groups were compared using one-way analysis of variance and the Scheffe test. The WAIS-R subtests were mutually compared based on the standard values of significant differences described in the WAIS-R manual. Verbal performance and full scale Intelligence Quotient (IQ) of WAIS-R were 87.7 ± 15.6 (mean ± standard deviation), 78.5 ± 18.1 and 81.0 ± 17.2, respectively, and verbal memory, visual memory, general memory, attention/concentration and delayed recall were 74.6 ± 20.0, 76.6 ± 21.4, 72.0 ± 20.4, 89.0 ± 16.5 and 65.2 ± 20.8, respectively. The competitive employment group showed significantly higher scores in performance IQ and full IQ on the WAIS-R and verbal memory, visual memory, general memory and delayed recall on the WMS-R and RBMT than the non-employment group. The sheltered employment group showed a significantly higher score in delayed recall than the non-employment group. No difference was observed in the FAB or BADS between the three groups. In the subtests of the WAIS-R, the score for Digit Symbol-Coding was significantly lower than almost all the other subtests. For patients with higher brain dysfunction, IQ (full scale IQ>53.2) and memory (general memory>74.1) are important indicators in returning to work under the conditions of competitive employment.

Keywords: higher brain dysfunction, neuropsychological test, employment, traumatic brain injury.

(Received 13 May 2008, accepted 11 August 2008)
Introduction

Higher brain dysfunction caused by traumatic brain injuries often demonstrates amnesia, inattention, executive dysfunction and social behavioral disorder, and these are some of the most important clinical conditions in the field of rehabilitation and welfare. In general, patients with higher brain dysfunction are regarded as healthy by ordinary people, because they usually have no physical disability, and may not be either properly diagnosed or trained. Because no social support systems have been developed in our country, the patients with higher brain dysfunction have been confronted with serious problems in returning to society and work [1].

To establish a proper medical and welfare service system for patients with higher brain dysfunction who have difficulty in social life and returning to work, the Ministry of Health, Labour and Welfare implemented a model project for supporting patients with higher brain dysfunction from the fiscal years 2001 to 2005. Our Department of Rehabilitation Medicine, University of Occupational and Environmental Health, Japan participated in this model project since 2001, and in 2006, after the end of the model project, our hospital was named as a cooperating institution in the national dissemination project for supporting patients with higher brain dysfunction. We see patients with higher brain dysfunction at our clinic who underwent acute phase treatments, and most of them have been hospitalized at our department for a few weeks for further neuropsychological evaluations and rehabilitation, and then return to society and/or work. Furthermore, a clinical psychologist joined our traumatic brain injury rehabilitation team as a support coordinator, and more comprehensive rehabilitation for patients with higher brain dysfunction has been developed in cooperation with the Kitakyushu Welfare Center for the Disabled and the Kitakyushu Branch of Local Vocational Center for Persons with Disabilities and others [2]. Despite these approaches, it is difficult for patients with higher brain dysfunction to return to society and especially to work. Therefore, we decided to examine the neuropsychological factors related to returning to work in patients with higher brain dysfunction who were hospitalized at our department for further neuropsychological evaluations.

Subjects and Methods

The subjects consisted of 92 consecutive patients with higher brain dysfunction (73 males, 19 females) who were hospitalized at the Department of Rehabilitation Medicine, University of Occupational and Environmental Health, Japan, during the period from February 2002 to June 2007 for further neuropsychological evaluation and rehabilitation, and who had returned to society and/or to work. The subjects were 36.3 ± 13.8 (mean ± standard deviation) years old (range: from 16 to 63), and their post-injury period was 35.6 ± 67.8 months. The causes of their diseases were traumatic brain injury in 53, cerebrovascular disease in 20, encephalitis in 6, hypoxic encephalopathy in 3 and others in 10.

We conducted the following tests in all subjects during hospitalization as a standard neuropsychological evaluation of higher brain dysfunction: Wechsler Adult Intelligence Scale-Revised (WAIS-R); Raven’s Coloured Progressive Matrices; Wechsler Memory Scale-Revised (WMS-R); the Rivermead Behaviour Memory Test (RBMT); Benton Visual Retention Test
Ray-Osterrieth Complex Figure Test (copy and reproduction in 3 minutes) [4]; Miyake's Paired Associated Memory Test [5]; Procedural Memory Test (mirror reading, mirror drawing and Toronto tower) [6]; Behavioral Assessment of Dysexecutive Syndrome (BADS); Frontal Assessment Battery (FAB) [7]; Wisconsin Card Sorting Test [8]; Kana pick-out test; Modified Stroop Test [9]; Trail Making Test [10]; Paced Auditory Serial Addition Test (PASAT) [11], and General Aptitude Test Battery (GATB) of the Ministry of Health, Labour and Welfare. Five neuropsychological tests (see underlined items) were adopted for analysis in this study: the Intelligence Quotient (IQ) values of WAIS-R were selected and analyzed for the intelligence scale, the indexes of WMS-R and the standard profile score of RBMT were selected and analyzed for the memory scale, and the total score of FAB and the standardized age-corrected score of BADS were selected and analyzed for the frontal lobe function scale. For patients who were hospitalized more than once, test values at the first admission were used.

Outcomes at 6 months (for employed patients) or 12 months (for unemployed patients) after discharge were classified under 3 groups: 1) the competitive employment group, which included persons employed by a company for a certain period of time under competitive employment conditions, including desk work and manufacturing (relocation and change of occupational functions sometimes occurred and returns to school were included in this group); 2) the sheltered employment group, which included employment of persons under special employment conditions (workshop, vocational aid centers, etc.) who were not employed under competitive employment conditions due to disabilities; 3) the non-employment group, which included persons in a state of unemployment.

When indexes of WAIS-R and WMS-R were less than 50, they were treated as 49 for analysis. A one-way analysis of variance was used to compare the test values between the three groups, and was followed by Scheffe test if a significant difference was obtained. P-values of less than 0.05 were regarded as significant. Subtests of WAIS-R were compared based on the standard values of significant differences described in the WAIS-R manual.

**Results**

The number of subjects was 10 and 8 for the competitive and sheltered employment groups, respectively, while 74 for the non-employment group. The verbal IQ of WAIS-R (mean ± standard deviation) in the competitive employment, sheltered employment and non-employment groups was 94.3 ± 16.3, 91.9 ± 23.0 and 84.8 ± 14.1, respectively; performance IQ was 92.5 ± 20.4, 89.4 ± 17.9 and 75.3 ± 16.3; full IQ was 92.7 ± 19.5, 89.6 ± 21.6 and 78.1 ± 15.4. The competitive employment group showed significantly higher scores in the performance IQ and full IQ than the non-employment group (Fig. 1: One-way Analysis of variance, Scheffe test, P<0.05). Verbal memory of WMS-R for the competitive employment, sheltered employment and non-employment groups was 92.6 ± 14.1, 84.3 ± 29.2 and 70.8 ± 17.9, respectively; visual memory, 91.7 ± 17.7, 90.0 ± 29.0 and 72.8 ± 19.5; general memory, 90.6 ± 16.5, 83.5 ± 30.6 and 68.0 ± 17.6; attention/concentration, 93.1 ± 19.8, 95.4 ± 15.5 and 87.5 ± 16.0; and delayed recall, 80.7 ± 19.7, 81.4 ± 31.8 and 61.0 ± 17.4. The competitive employment group
showed significantly higher scores in the verbal memory, visual memory, general memory and delayed recall than the non-employment group, while the sheltered employment group showed a significantly higher score in the delayed recall than the non-employment group (Fig. 2: One-way Analysis of variance, Scheffe test, $P<0.05$). RBMT was $17.4 \pm 4.4$, $15.0 \pm 7.6$ and $11.4 \pm 7.5$ in the order of the competitive employment, sheltered employment, non-employment groups, and the competitive employment group showed a significantly higher score than the non-employment group (Fig. 3: One-way Analysis of variance, Scheffe test, $P<0.05$). FAB was $16.0 \pm 1.8$, $15.3 \pm 2.9$ and $14.0 \pm 3.0$ in the order of the competitive employment, sheltered employment and non-employment groups, while BADS was $97.6 \pm 18.5$, $98.5 \pm 20.1$ and $86.9 \pm 19.1$. No significant difference in FAB or BADS was found between the three groups (Fig. 3: One-way Analysis of variance, $P>0.05$). In the subtests of WAIS-R, the score of Digit Symbol-Coding was significantly lower compared to the subtests of knowledge, counting, words, math, comprehension, similarity and blocks. Moreover, the knowledge score was significantly lower than the counting score (Fig. 4.)
**Fig. 2.** Wechsler Memory Scale-Revised in the three groups.
- ■: Competitive employment group,
- □: Sheltered employment group,
- □: Non-employment group,
- *: One-way Analysis of variance followed by Scheffe test, *P*<0.05.

**Fig. 3.** Rivermead Behaviour Memory Test, Frontal assessment battery and Behavioural assessment of the dysexecutive syndrome in the three groups.

- RBMT: The Rivermead Behavioural Memory Test,
- FAB: Frontal Assessment Battery,
- BADS: Behavioural Assessment of the Dysexecutive Syndrome,
- ■: Competitive employment group,
- □: Sheltered employment group,
- □: Non-employment group,
- *: One-way Analysis of variance followed by Scheffe test, *P*<0.05.
From the results of the neuropsychological tests, the patients with higher brain dysfunction had mild intellectual deterioration (slight decrease in WAIS-R) and frontal lobe dysfunction (slight decrease in FAB and BADS), and had obvious memory impairment (decrease in WMS-R and RBMT). Among the tests for intelligence, the performance IQ was lower than the verbal IQ and among the tests for memory, delayed recall was undoubtedly deteriorated. These findings give a general understanding of the impairments associated with higher brain dysfunction. In addition, Digit Symbol-Coding, one of subtests of WAIS-R, was low, possibly indicating decreased processing speeds for operations and learning among patients with higher brain dysfunction. Our results were consistent with previous studies on performance IQ and subtests of digit symbol and picture arrangement which were low in traumatic brain injury patients [11, 12]. At our clinic, we often see patients with higher brain dysfunction who give the impression that they are slow in comprehending things and need more concentration compared with their intelligence.
level, and the characteristics of the impairments of higher brain dysfunction obtained in this study properly explain this situation.

Regarding the outcomes after discharge, which were classified into three, and the findings of the neuropsychological tests, the test values showed a tendency to decrease in the order of the competitive employment, sheltered employment and non-employment groups. Differences between the competitive employment and non-employment groups were in the areas of intelligence (performance IQ and full IQ of WAIS-R) and memory (verbal memory, visual memory, general memory and delayed recall of WMS-R and RBMT), and a difference between the sheltered employment and non-employment groups was in the area of memory (delayed recall of WMS-R). Although the rate of return to work cannot be determined solely based on results of the neuropsychological tests, scores of at least 53.2 in full IQ and at least 74.1 in general memory would be one of the indicators of competitive employment, if one adopts “mean –1 standard deviation” as a referential value. For return to work, the severity of memory impairment is a more important disincentive than intellectual deterioration.

The analysis of this study showed no significant differences in the values of the neuropsychological tests between the competitive employment and sheltered employment groups, suggesting that other factors except intelligence and memory, that is, factors of a company and a patient, are involved. Factors of a company may include its management policy and the managing status of a company, its capability for relocation and changes in occupational functions, and the understanding of supervisors and coworkers in a company with regard to higher brain dysfunction. Factors of a patient may include the strong will to return to work, the presence or absence of social behavioral impairments, vocational capability and special license. Maruishi et al. reported that neuropsychological findings did not affect their employment rate in patients with the same severity based on the classification of the Ministry of Health, Labor and Welfare, and that non-personal factors were responsible for the difference in employment rates [14].

In this study, the results of only 5 tests (WAIS-R, WMS-R, RBMT, FAB and BADS) during hospitalization were analyzed, and it is necessary to add other neuropsychological findings and factors related to the company and patient for discussing support programs for return to society and/or to work.

**Conclusion**

The neuropsychological tests in this study revealed that the characteristics of disabilities associated with higher brain dysfunction, that is, WMS-R and RBMT, were low compared to WAIS-R, FAB and BADS, and that Digit Symbol-Coding decreased in the subtests of WAIS-R. The test values decreased in the order of the competitive employment, sheltered employment and non-employment groups: the competitive employment group was better in performance and full IQ of WAIS-R, verbal memory, visual memory, general memory and delayed recall of WMS-R and RBMT than the non-employment group; the sheltered employment group was better in delayed recall of WMS-R than the non-employment group. For patients with higher brain
dysfunction who wish to return to work under the conditions of competitive employment, IQ (full IQ > 53.2) and memory (general memory > 74.1) are indicators.

References

高次脳機能障害者の職場復帰に関連する神経心理学的要因

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要 旨： 高次脳機能障害者に神経心理学的検査を実施し、雇用に関与する障害の特徴を検討した。2002年2月～2007年6月に社会復帰を目的に当院に入院した高次脳機能障害患者92名（平均年齢36.3歳、範囲：16～63歳、受傷後期間35.6ヶ月）を対象とし、Wechsler Intelligence Scale-Revised (WAIS-R), Wechsler Memory Scale-Revised (WMS-R), the Rivermead Behavioral Memory Test (RBMT), Frontal Assessment Battery (FAB) and Behavioral Assessment of Dysexecutive Syndrome (BADS)を実施した。退院後の帰結により一般雇用、保護雇用、非雇用に分け、3群間を比較した。WAISの下位検査項目は手引きの有意差基準をもとに相互比較をした。一般雇用群は非雇用群に比べてWAIS-RのPerformance Intelligence Quotient (IQ), Full sale IQ, WMS-Rの言語性記憶、視覚性記憶、一般的記憶、速延再生、RBMTが有意に高得点であった。保護雇用群は速延再生が非雇用群よりも有意に高得点であった。FABとBADSには3群間で相違はなかった。WAIS-Rの下位検査項目では符号が低得点であった。高次脳機能障害者の職場復帰の観点からは、IQと記憶が重要な要因である。

キーワード： 高次脳機能障害、神経心理学的検査、雇用、外傷性脳損傷。

J UOEH（産業医大誌）30（4）：403－411 (2008)