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Neuropsychological signs in stroke patients according to Bender Visual Motor Gestalt Test

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Objective : *To test neuropsychological signs in stroke patients using Bender Visual Motor Gestalt Test*

Research design : *Retrospective analytical study*

Setting : *The Thai Red Cross Rehabilitation Center*

Patients : *Stroke patients who were older than 35 years old, admitted between 1998 - 2006 and completed Bender Visual Motor Gestalt Test.*

Methods : *Medical records and results of the Bender Visual Motor Gestalt Test for stroke patients were reviewed. The total number of records that met the criteria was 200. The patients' scores were classified to degrees of brain impairment. The scores were compared based on age, education, side of weakness and severity levels. Statistical analysis was performed by SPSS program.*

Results : *Bender Visual Motor Gestalt Test showed 79.5 % of visuospatial, visuoconstruction and visuomotor brain impairments in stroke patients. Strong and very strong evidences of impairment were found in 46.5 % of them. Left hemiplegic patients had more impairment than those who had right hemiplegic. There were significant differences in error regarding age, education, side of weakness and severity level.*

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Conclusion : *Bender Visual Motor Gestalt Test is a useful test on neuropsychological signs in stroke patients who have visuospatial, visuoconstruction and visuomotor impairments. Left hemiplegic patients had more impairment than those with right hemiplegic. Patients with young age, high education and low severity have less impairment.*

Keywords : *Stroke, Neuropsychological signs, Bender Visual Motor Gestalt Test, Rehabilitation.*

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วัตถุประสงค์ : *เพื่อศึกษาอาการแสดงทางประสาทจิตวิทยาของผู้ป่วยโรคหลอดเลือดสมองด้วยแบบทดสอบเบนเดอร์ วิชวล มอเตอร์ เกสตอลท์*

รูปแบบการวิจัย : *การศึกษาย้อนหลังเชิงวิเคราะห์*

สถานที่ทำการวิจัย : *ศูนย์เวชศาสตร์ฟื้นฟู สภากาชาดไทย*

กลุ่มประชากร : *ผู้ป่วยโรคหลอดเลือดสมองที่รับเข้ารักษาแบบผู้ป่วยในของศูนย์เวชศาสตร์ฟื้นฟูระหว่างปี พ.ศ.2541 - 2549 มีอายุมากกว่า 35 ปีเมื่อเป็นโรค และมีข้อมูลการทดสอบเบนเดอร์ วิชวล มอเตอร์ เกสตอลท์ครบสมบูรณ์*

วิธีการศึกษา : *รวบรวมข้อมูลจากเวชระเบียนและผลการทดสอบจากแบบทดสอบเบนเดอร์ วิชวล มอเตอร์ เกสตอลท์ของผู้ป่วยโรคหลอดเลือดสมอง ผู้ป่วยที่อ่อนแรงซีกซ้ายหรือซีกขวาทั้งสิ้น 200 คน เปรียบเทียบความแตกต่างระหว่างอายุ ระดับการศึกษา ข้างที่อ่อนแรงและความรุนแรง คำนวณทางสถิติโดยใช้โปรแกรม SPSS*

ผลการทดสอบ : *พบอาการแสดงทางประสาทจิตวิทยาด้าน visuospatial, visuoconstruction และ visuomotor impairments ในผู้ป่วยโรคหลอดเลือดสมอง ร้อยละ 79.5 ผู้ป่วยร้อยละ 46.5 มีผลการทดสอบระดับ strong และ very strong evidence และพบความผิดปกติในผู้ป่วยอ่อนแรงซีกซ้ายมากกว่าขวาอย่างมีนัยสำคัญทางสถิติ ผู้ป่วยที่มีอายุ ระดับการศึกษา ข้างที่อ่อนแรง และระดับความรุนแรงของโรคต่างกันมีคะแนนจากการทดสอบแตกต่างกันอย่างมีนัยสำคัญทางสถิติ*

สรุป : *แบบทดสอบเบนเดอร์ วิชวล มอเตอร์ เกสตอลท์สามารถค้นหาอาการแสดงทางประสาทจิตวิทยาด้าน visuospatial, visuoconstruction และ visuomotor impairments ได้ พบความผิดปกติในผู้ป่วยโรคหลอดเลือดสมองที่อ่อนแรงซีกซ้ายมากกว่าอ่อนแรงซีกขวา ผู้ป่วยที่มีอายุน้อย ระดับการศึกษาสูง และระดับความรุนแรงน้อยเป็นกลุ่มที่มีความผิดปกติน้อย*

คำสำคัญ : *โรคหลอดเลือดสมอง, อาการแสดงทางประสาทจิตวิทยา, แบบทดสอบเบนเดอร์ วิชวล มอเตอร์ เกสตอลท์, การฟื้นฟูสมรรถภาพ*

Stroke is a clinical syndrome characterized by an abrupt development of clinical signs and symptoms of focal or global deficits that last at least 24 hours or leading to death with no apparent cause other than of vascular origin that incorporated hemorrhage and ischemic lesions. This is the third leading cause of death in the United States of America.[1] Stroke is also a common public health problem and also a leading cause of disability and handicap in Thailand. Its prevalence was 690 per 100,000 persons and 9.6 % of all disabled in our country.[2] Stroke had many symptoms and signs, e.g., hemiparesis, hemianesthesia, dysphasia, perceptual deficit. Neuropsychological signs can be found in stroke patients but it is difficult to specifically detect.[3] Neuropsychological tests are specifically designed investigative procedure for the study of psychological functions known to be linked to the brain structure or pathway.[4] Bender Visual Motor Gestalt Test is a neuropsychological tool that psychologists usually use to identify possible organic brain damage and the degree of maturation of the nervous system. It was developed by Lauretta Bender, a psychiatrist in 1938.[5] It is one of the most common psychological tools used by clinical psychologists in the United States.[6] This test is used to evaluate visuospatial, visuoconstruction and visuomotor skills in children and adults.[5, 7] As we known, there is no study on the usefulness of this test in stroke rehabilitation in Thailand. In this study, we determine the usefulness of Bender Visual Motor Gestalt Test for detecting neuropsychological signs especially visuospatial, visuoconstruction and visuomotor aspects in stroke patients and to compare the scores between different age groups, education, side of weakness and severity.

Materials and Methods

Research design

A retrospective analytical study.

Setting

The Thai Red Cross Rehabilitation Center, Samutprakarn province, Thailand.

Populations

Stroke patients who were admitted in the Thai Red Cross Rehabilitation Center between March 1, 1998 to December 31, 2006.

Methods

We reviewed medical records of unilateral stroke patients who had complete results of Bender Visual Motor Gestalt Test. Exclusion criteria were: 1) a bilateral hemiparetic patient; 2) age less than 35 years old at the onset; and, 3) had some problems that impeded a test, e.g., severe communication disorders, visual impairment, and severe musculoskeletal problems of the sound hand.

Bender Visual Motor Gestalt Test is a pencil-and-paper test with non-verbal responsive component of a patient. There are nine geometric figures drawn in black (see Appendix). They are administered to each patient in a quiet environment. Each patient was tested only once with 2 steps, namely: step 1, the examiner shows each figure one at a time to the patient. The patient is then asked to copy the figure on a blank sheet of paper. The patient is not allowed to use any ruler or other aids; step 2, the patient is requested to draw the figure from the memory. The test duration lasts around 30 minutes.

The test was scored according to Lacks' system.[8] It has a total of 12 points of error/ difficulties. Each error scores 1 point and the highest score is 12. The error/difficulty includes rotation, overlapping

difficulty, simplification, fragmentation, retrogression, perseveration, collision or collision tendency, impotence, closure difficulty, motor in-coordination, angulation and cohesion. The cutoff score is 5 or over. The category of evidence of visuospatial, visuoconstruction and visuomotor is classified by the numbers of error. Score of 0 – 3 means the absence of brain impairment; 4, borderline; 5 – 6, some evidence; 7 – 8, strong evidence of brain impairment; and, 9 – 12, very strong evidence of brain impairment.

Statistical analysis

The data were analyzed using SPSS statistics program (version 10.0, SPSS Inc., Chicago, IL, USA). The demographic data are shown in descriptive. Scoring of patient is shown as mean ± SD. One-way ANOVA with Scheffe post hoc correction and chi-square test are used for comparing data between different age groups, education, side of weakness and severity. The p-value < 0.05 was considered significant.

This study has been approved by the ethics committee of the Faculty of Medicine (IRB), Chulalongkorn University.

Results

A total of 200 records were collected. One hundred of them were right hemiparetic patients. The other 100 were left hemiparetic. Sixty percents were male. Most of them were in a 50 – 64 years old group. Half of them had only primary school education. Merchant and employee were 60 %. Forty percent were left hemiparetic.Demographic data and comparison of the data between the right and the left hemiplegic patients is shown in table 1.

Bender Visual Motor Gestalt Test showed evidence of visuospatial, visuoconstruction and visuomotor impairments in 79.5 % of stroke patients. We used chi-square test to determine the significant difference of the degree of impairment between right and left hemiparesis/plegia. Right hemiparesis/plegia was significantly more frequent than the left hemiparesis/plegia in "some evidence of impairment" group. According to the "very strong evidence" group, the left hemiparesis/plegia was significantly more than the right hemiparesis/plegia. If a "strong evidence" was merged with a "very strong evidence" group before analysis, the number left hemiparesis/plegia was also significantly higher than that of the right hemiparesis/plegia. "Absent of brain impairment" and "borderline" groups were not significantly different between the right and left hemiparesis/plegia. The categories of evidence are shown in table 2.

The most common errors found in all patients were perseveration, closure difficulty and simplification, respectively. Stroke patient with right hemiparesis/plegia had the common errors on perseveration, closure difficulty, simplification, motor in-coordination and overlapping difficulty. Perseveration, simplification, closure difficulty, overlapping difficulty and retrogression were the common errors found in the left hemiparesis/plegia. The percentage of each error found in stroke patients is shown in table 3.

Stroke patients in older age group showed more error than younger age group. The 50 – 64 years old and 65 – 80 years old groups had more significant error than a 35 – 49 years old group. No significance between 50 – 64 years old group and that of the 65 – 80 years old group. The mean errors of each age group are shown in table 4.

Table 1. Demographic data.

Characteristics	N (%)			P value
	Total	Right hemiplegia/paresis	Left hemiplegia/paresis	
Gender				
- male	120 (60)	61 (30.5)	59 (29.5)	0.774
- female	80 (40)	39 (19.5)	41 (20.5)	
Age (years)				
- 35-49	46 (23)	13 (6.5)	33 (16.5)	1.00
- 50-64	90 (45)	47 (23.5)	43 (21.5)	
- 65-80	64 (32)	31 (15.5)	33 (16.5)	
Education				
- primary	98 (49)	49 (24.5)	49 (24.5)	0.927
- secondary	65 (32.5)	33 (16.5)	32 (16)	
- undergraduate	37 (18.5)	18 (9)	19 (9.5)	
Career				
- official	47 (23.5)	23 (11.5)	24 (12)	0.181
- merchant	56 (28)	30 (15)	26 (13)	
- employee	57 (28.5)	18 (9)	39 (19.5)	
- farmer	16 (8)	13 (6.5)	3 (1.5)	
- unemployed	24 (12)	16 (8)	8 (4)	
Severity of disease				
- Hemiparesis	153 (76.5)	70 (35)	83 (41.5)	0.030
- Hemiplegia	47 (23.5)	30 (15)	17 (8.5)	

Table 2. The right and left hemiplegic patients in each category of the Bender Visual Motor Gestalt Test.

Category	Rt. hemiparesis/ plegia, N (%)	Lt. hemiparesis/ plegia, N (%)	$\bar{X} \pm SD$	P value
- Absence of impairment	15 (7.5)	11 (5.5)	2.65 ±0.63	0.433
- Borderline	8 (4)	7 (3.5)	4.00 ±0.00	0.796
- Some evidence	42 (21)	24 (12)	5.53 ±0.50	0.027
- Strong evidence	21 (10.5)	31 (15.5)	7.48 ±0.51	0.166
- Very strong evidence	14 (7)	27 (13.5)	9.37 ±0.58	0.042
- Strong and very strong evidence	35 (17.5)	56 (29)	8.31 ±1.08	0.017

Table 3. The percentage of the error/difficulty in stroke patients tested by the Bender Visual Motor Gestalt Test.

Error/difficulty	Rt.hemiparesis/plegia (N)	Lt.hemiparesis/plegia (N)	Total, N (%)
Rotation	23	34	57 (28.5)
Over Lapping difficulty	63	79	142 (71)
Simplification	82	85	167 (83.5)
Fragmentation	3	28	31 (15.5)
Retrogression	46	71	117 (58.5)
Perseveration	86	89	175 (87.5)
Collision/collision tendency	51	58	109 (54.5)
Impotence	16	20	36 (18)
Closure difficulty	84	84	168 (84)
Motor in coordination	81	46	127 (63.5)
Angulation	45	63	108 (54)
Cohesion	10	20	30 (15)

Table 4. Mean errors of stroke patient in each age group.

Age group	N (%)	$\bar{X} \pm$ SD	P value	Post hoc analysis, P value
35-49	46 (23)	5.33 ± 2.28	0.001	vs. 50-64; 0.015, vs. 65-80; 0.001
50-64	90 (45)	6.47 ± 2.27		vs. 35-49; 0.015, vs. 65-80; 0.509
65-80	64 (32)	6.88 ± 1.84		vs. 35-49; 0.001, vs. 50-64; 0.509

Stroke patients with higher education had less error than lower education significantly. Those with undergraduate education and secondary school had significantly lower error than those who had primary school education. Patients with secondary school education had significantly lower error than those with primary school but not significant difference with the undergraduate group. The mean score of stroke patients in each level of education is shown in table 5.

Table 5. Mean errors of stroke patients in each level of education.

Education	N (%)	$\bar{X} \pm$ SD	P value	Post hoc analysis, P value
Primary	98 (49)	7.03 ± 1.95	0.000	vs. secondary; 0.001, vs. undergraduate; 0.001
Secondary	65 (32.5)	5.78 ± 2.28		vs. primary; 0.001, vs. undergraduate; 0.757
Undergraduate	37 (18.5)	5.46 ± 2.23		vs. primary; 0.001, vs. secondary; 0.757

Table 6. Mean error of right and left hemiplegia and severity of weakness.

Characteristics	N (%	$\bar{X} \pm SD$	P value
Lt.hemiparesis/plegia	100 (50)	6.77 ± 2.29	0.005
Rt.hemiparesis/plegia	100 (50)	5.90 ± 2.05	
Hemiparesis	153 (76.5)	6.07 ± 2.17	0.002
Hemiplegia	47 (23.5)	7.19 ± 2.16	

A left hemiplegic patient had significantly higher error than one with right hemiplegic. A hemiplegia patient had significantly higher error than a hemiparetic patient. The mean error of right and left hemiplegia and severity of weakness are shown in table 6.

Discussion

Bender Visual Motor Gestalt Test detects an error/difficulty of visuospatial, visuoconstruction and visuomotor skills. According to Lack's criteria, this test determined neuropsychological impairment in 79.5 % of stroke patients in our study. There is more than other study. If excluded "some evidence of impairment" group, the impairment decreased to 46.5 %. The right hemiparesis/plegia was significantly more common than the left hemiparesis/plegia in "some evidence of impairment" group. There may be caution for false positive when interpreted impairment in this group. The left hemiparesis/plegia was significantly more than the right hemiparesis/plegia in "strong evidence" and "very strong evidence" groups. There is reasonable correlation between a recent study [9] and our findings.

Severity of weakness is also important. Hemiplegic patients have significantly higher error than hemiparetic patients. Hemiplegic patients usually have more severity and area of brain involvement than hemiparetic patients. Incomplete lesion in hemiparetic patients may spare some functions and good opportunity to recovery. There is a reason why we found less error during testing in hemiparetic group. Lesion size and site were studied in brain injury patient.[10] The right posterior brain lesion had highest error and the left anterior lesion had lowest error. The size of lesion was not correlated with visualconstruction skills. There is no study about correlation of lesion size and site in stroke patient. We cannot correlate them in our study. There should be studied in the future.

Education and age was affected number of error in this test. Patients with older age and lower education had higher degree of error. [11-13] Normally, patients who had higher education are usually familiar with geometric figures, drawing and the use of pencil and paper test. Old age is also related to poorer eye-hand coordination and memory.[13-17] This caused an older and lower education group have higher errors.

The most common errors found in all patients were perseveration, closure difficulty and simplification, respectively. They are correlated to thinking process problems such as poor decision making, improper planning strategy, learning new task difficulty, incoherent thinking, and fluctuated thinking

process.[11, 18, 19] Left hemiplegic patients had more overlapping difficulty which is different from those with right hemiplegia. They are referred to as figure-ground impairment and perceptual deficit. [12, 17, 18] Right hemiplegic patients had more motor in-coordination error than those with left hemiplegic. This is referred to as motor programming problem.[19, 20] The error/ difficulty resulted in difficult to trained activities of daily living and ambulation. This impairment is one of the common rehabilitation obstacles.

Each error informs a specific area of impairment. For example, perseveration represented incoherent, fluctuation and slowness of thinking, lack of perception and learning new tasks. Errors in cohesion represented lost of self-control, location and size perception deficit and error in decision making and planning. [12, 17, 18, 21, 22] We can use the specific impairment/error to find out the most benefit strategy or training method for individual patient. This helps psychologists/ therapists to design tailored made training programs. Psychologists/therapists can use this test for finding neuropsychological signs on admission and for evaluating training program on discharge.

No previous studies in Thailand according to usefulness of the Bender Visual Motor Gestalt Test for detecting neuropsychological signs in stroke patient during rehabilitation were done. This test is usually used in traumatic brain injury and child with brain damage groups. Our result represents the benefit of this test in stroke patient especially for detecting visuospatial, visuoconstruction and visuomotor impairments that common found during rehabilitation. The training of a specific error detected from this test could resolve an obstacle and facilitate rehabilitation program. Finally, a prospective study should be done for determining an outcome after specific training. The usefulness of this test as an outcome measure should be done in the future.

Conclusion

The Bender Visual Motor Gestalt Test has a benefit on neuropsychological signs in stroke patients who have visuospatial, visuoconstruction and visuomotor impairments. There is also a benefit for testing some cognitive function such as thinking process. Left hemiplegic patients had more impairment than the ones with right hemiplegic. Patients with advancing age, low education and high severity have higher error.

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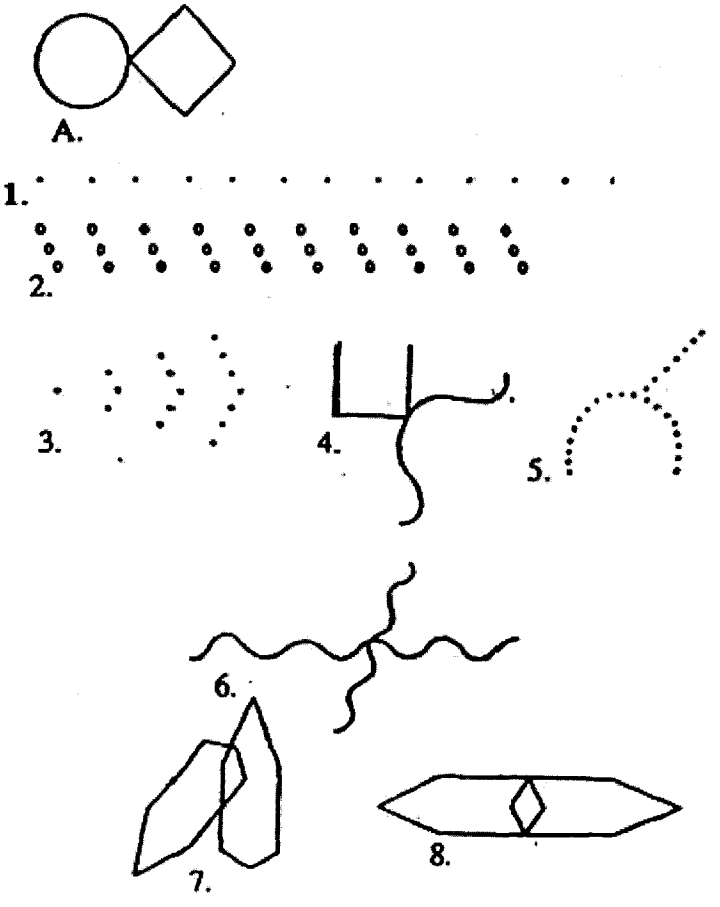
Appendix



The Bender Visual Motor Gestalt Test