Reliability Study of White Matter Rating Scale for the Dementia and Disability in Thai Elderly Project

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Objective: *To study the reliability of white matter rating scale on magnetic resonance imaging (MRI) of elderly patients in the urban community of Bangkok.*
Material and Method: *One hundred elderly with clinical diagnosis of cognitive impairment in the urban community around Siriraj Hospital underwent cranial MRI according to the Dementia and Disability in Thai Elderly Project. The axial T_{1wi}, T_{2wi}, and fluid attenuated inversion recovery (FLAIR) were separately assessed by two neuroradiologists. The assessment included white matter change by using Scheltens' rating scale, atrophy, and evidence of infarction. The inter-rater agreements were analyzed.*
Results: *The inter-rater agreement of periventricular hyperintensities, white matter, basal ganglion and infratentorial foci of hyperintensities were very good (ICC = 0.89-0.98).The agreement was good for central atrophy (K_w = 0.66) and moderate for cortical atrophy (K_w = 0.49). The silent infarction was found in the study population and divided into cortical (15%), subcortical (26%), brainstem (3%), and infratentorial infarction (8%).*
Conclusion: *White matter hyperintensities was an important radiological criteria for diagnosis of vascular dementia. Appropriate rating scale is necessary especially in research study. The authors found that Scheltens' rating scale needed some training and slightly time consuming at the beginning but was a good reliable tool.*

Keywords: *Dementia, Dementia vascular, Diagnosis, Magnetic resonance imaging, Reproducibility of results*

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Abnormal signal intensity at periventricular and deep white matter demonstrated on magnetic resonance imaging (MRI) was reported in healthy elderly and in patients with dementia including Alzheimer's disease (AD)[1-7]. However, it has been proved that the white matter change in demented patients was significantly related to diagnosis, prognosis, and treatment. Epidemiologic study of the prevalence, causes, and prognosis is still limited because of lack of reliable criteria for grading the severity and clinical importance of the lesions.

There were many white matter rating scales proposed mostly for statistical analysis in the researches. These included Manolio's, Fasekas', and Scheltens' scales[5,8,9]. Kapellar et al studied by comparing interrater agreement and correlation with quantitative measurement between these three scales and found better values in the Fasekas' and Scheltens' scales[10]. The reason is that these two scales provided more detailed information on white matter change.

The present study was a part of the study in Dementia and Disability in Thai Elderly Project. The purpose of the study was to evaluate the reliability of diagnostic tool for white matter change (the authors choose the Scheltens' scale) on MRI of the community population in Bangkok with cognitive impairment. The authors also would like to test the feasibility of choosing this scale for the present study.

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Material and Method

The present study was approved by the Ethical Committee of the institute. Elderly in the community around the hospital were examined for the

cognitive impairment. The inform consent was done in all the people enrolled into the present study. The cranial MRI was performed in cases diagnosed cognitive impairment. The axial T_{1wi}, T_{2wi}, and fluid attenuated inversion recovery (FLAIR) were performed for evaluation of white matter change, cerebral atrophy, and evidence of infarction. The three-dimension T_{1wi} (3D-T_{1wi}) was done for volumetric measurement.

One hundred MRI studies were randomly selected for white matter rating. Two neuroradiologists separately evaluated the axial images and blindly from clinical information. The method of the Scheltens' rating scale was provided before the evaluation (Table 1)[9]. Besides this, both radiologists also evaluated the images for cortical and central atrophy and evidence of infarction. For brain atrophy, images of visual rating scale were also provided as none, moderate and severe atrophy (Fig. 1, 2).

The rating scores from both raters were calculated for inter-rater agreement by using weighted Kappa statistics (K_w). The total scores were compared by using intraclass correlation (ICC). The atrophy was also compared by using weighted Kappa statistics. The prevalence of infarction was calculated.

The authors predetermined the K_w and ICC values along with the degree of agreement as poor (< 0.2), fair (0.21-0.4), moderate (0.41-0.6), good (0.61-0.8) and very good (0.81-1).

Results

For periventricular white matter hyperintensity, the agreement was very good (ICC = 0.89, 95% CI = 0.84-0.93) (Table 2). The inter-rater agreements were fair to good for each location (Table 3).

The deep white matter hyperintensity score between two raters was very good in agreement (ICC = 0.98, 95% CI = 0.97-0.99) (Table 2). The degrees of agreements in each lobe of brain were good to very good (Table 3).

For basal ganglion hyperintensity, the inter-rater agreement was very good (ICC = 0.97, 95% CI = 0.96-0.98) (Table 2) while agreements for scores of each location of basal ganglion were good to very good (Table 3).

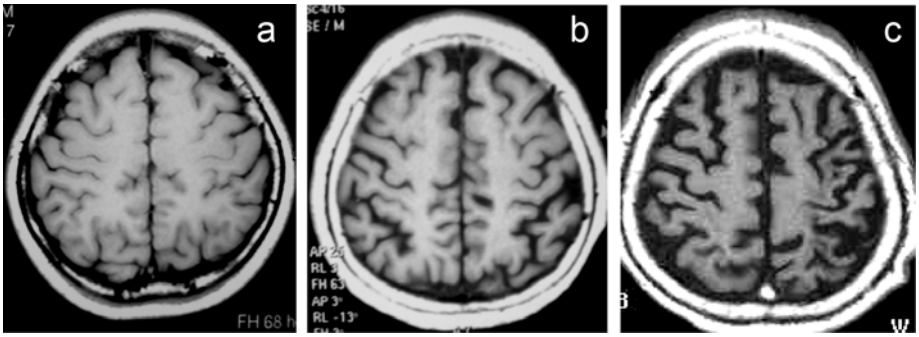

Fig. 1 Visual rating scale for cortical atrophy: a = none, b = moderate, c = severe

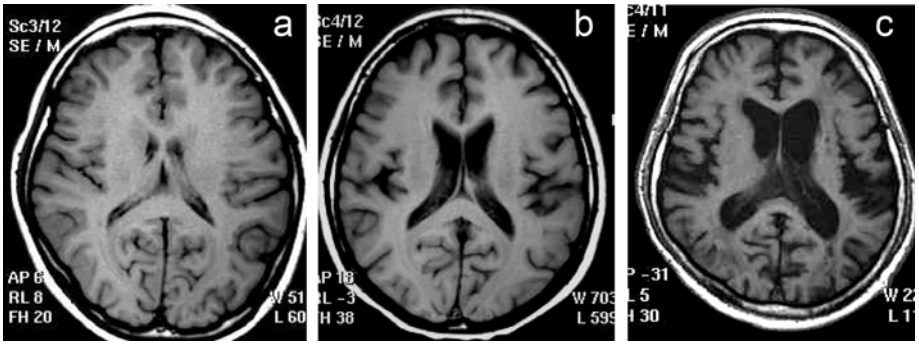

Fig. 2 Visual rating scale for central atrophy: a = none, b = moderate, c = severe

Table 1. The Scheltens' rating scale[9]

PVL	Frontal caps	0 = none
	Occipital caps	1 = smooth halo (> 1-5 mm)
	Bands	2 = large confluent lesions (5-10 mm)
DWMH	Frontal	
	Parietal	
	Occipital	
	Temporal	0 = none
Basal ganglia	Caudate nucleus	1 = < 4 mm; n ≤ 5
	Putamen	2 = < 4 mm ; n > 5
	Globus pallidus	3 = 4-10 mm; n ≤ 5
	Thalamus	4 = 4-10 mm; n > 5
	Int/ext capsule	5 = > 10 mm; n ≥ 1
Infratentorial	Cerebellum	6 = confluent
	Mesencephalon	
	Pons	
	Medulla	

Table 2. Inter-observer agreement of rating of white matter hypersignal intensity

Total (n = 100)	Intraclass correlation, (95% CI)
Periventricular hypersignal intensity	0.89 (0.84-0.93)
White matter hypersignal intensity	0.98 (0.97-0.99)
Basal ganglia hypersignal intensity	0.97 (0.96-0.98)
Infratentorial foci of hyperintensity	0.93 (0.90-0.95)

Table 3. Inter-observer agreement of rating of white matter for each part (n = 100)

Periventricular hypersignal intensity	K_w (95% CI)
Frontal caps	0.698 (0.523-0.872)
Occipital caps	0.689 (0.532-0.846)
Bands	0.502 (0.355-0.649)
White matter hypersignal intensity	K_w (95% CI)
Frontal	0.909 (0.858-0.959)
Parietal	0.885 (0.828-0.942)
Occipital	0.870 (0.789-0.950)
Temporal	0.778 (0.644-0.911)
Basal ganglia hypersignal intensity	K_w (95% CI)
Caudate n.	0.828 (0.648-1.006)
Putamen	0.852 (0.705-0.999)
Globus	0.756 (0.593-0.918)
Thalamus	0.850 (0.681-1.018)
Internal capsules	0.851 (0.737-0.964)
Infratentorial foci of hyperintensity	K_w (95% CI)
Cerebellar	0.668 (0.505-0.830)
Mesencephalon	0.532 (0.357-0.706)
Pons	0.874 (0.748-0.999)
Medulla	cannot be calculated

For infratentorial foci of hyperintensity, the agreement was very good and for each part the agreements were fair to very good (Table 2, 3).

The agreement of central atrophy was good (K_w= 0.66, $p < 0.001$) and cortical atrophy was fair (K_w= 0.49, $p < 0.001$).

There were 15 cases (15%) with cortical infarction, 26 cases (26%) of subcortical infarction, three cases (3%) of brainstem infarction, and eight cases (8%) of infratentorial infarction found in the present study.

Discussion

Dementia is the major devastating cause for health care budget in the elderly. The common causes of dementia are Alzheimer's disease (AD) and vascular dementia (VaD). Through AD is the major group, it is believed that mixed VaD and AD is going to be increased and may be the leading group of demented patients in the future. The most popular and accepted criteria for diagnosis of VaD was concluded from the NINDS-AIREN Working Group[11]. With this criteria, neuroimaging plays an important role in evaluating of vascular change in the brain. Without evidence from CT or MRI, diagnosis for VaD is not better than possible. In cases with evidence of hemispheric infarction or multiple lacunar infarction, diagnosis is not a problem. However, in cases with only white matter change, diagnosis may be uncertain.

Although pathophysiology of white matter change on CT and MRI is still not clearly known, destruction of small vessels in periventricular and deep white matter is believed to be the cause[12]. The NINDS-AIREN criteria stated that white matter change alone is enough for diagnosis of VaD if the changes involve 25% or more of the white matter[11]. Many reports supported the relationship of cognitive dysfunction and severe white matter change[13,14]. However, lesser degree of white matter change may be associated with AD and important in AD[7].

Studies about VaD have been found relationship of VaD and AD. Trials in treatment of cholinesterase inhibitors and other AD drugs are also interesting. These have affected more discussion for suitable white matter rating scale both in the aspects of location and severity. The main purpose of rating scales is to provide a score that can be used in statistical analysis. Moreover, the rating scales are used to full-fill the NINDS-AIREN criteria as discussed before and identify the homogeneity of the studied patients with AD.

There are many rating scales using CT and MRI in the literatures. The ideal scales should include anatomical location and severity of the lesions. In practice, it should not take too much time and have good inter- and intra-rater reliability. In the present study, the authors chose the Scheltens' rating scale because more details of location and severity. The present study was not much different from Scheltens' study[9]. By using this scale, the authors found that it took time at least 10 minutes at the beginning and reduced to 5 minutes later on and needed practice. The recent report by Wahlund et al for new rating scales proposed an easier scale[15]. This rating scale combined both CT and MRI and defined periventricular white matter (cap and band) as normal finding. The white matter scale was scored in deep white matter and basal ganglion. The scale is also simple. However, this rating scale has not been studied for validity and clinical impact or relationship with severity of the disease.

Conclusion

White matter rating scale is an important tool in the study of white matter change in dementia project. Choosing the appropriate scale and reliability test in the studied population is needed.

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การศึกษาความน่าเชื่อถือของการจัดลำดับการวัด white matter สำหรับภาวะสมองเสื่อม และภาวะไร้ความสามารถในโครงการคนไทยสูงอายุ

อรสา ชวาลภาฤทธิ์, สุวิมล วงศ์ลักษณะพิมล, ฑิตพงษ์ ส่งแสง, วรพรรณ เสนาณรงค์

วัตถุประสงค์: *เพื่อศึกษาความน่าเชื่อถือของการจัดลำดับการวัดความผิดปกติของเนื้อขาวสมอง ของ Scheltens ในภาพเอ็มอาร์ไอสมอง*

วัสดุและวิธีการ: *ผู้สูงอายุ 100 ราย ซึ่งมีภาวะไร้ความสามารถอย่างอ่อนหรือภาวะสมองเสื่อมจากชุมชนรอบ ๆ โรงพยาบาลศิริราชได้รับการตรวจภาพเอ็มอาร์ไอสมองตามโครงการวิจัยภาวะสมองเสื่อมและความทุพพลภาพในผู้สูงอายุไทย ภาพตัดขวางตามแกนกลาง T_{1Wi}, T_{2Wi} และ fluid attenuated inversion recovery (FLAIR) ของภาพเอ็มอาร์ไอ สมองถูกนำมาใช้แปลผลโดยรังสีแพทย์ซึ่งมีความชำนาญทางระบบประสาท 2 ท่าน ทำการแปลผลแยกกัน การแปลผลภาพเอ็มอาร์ไอสมองประกอบด้วย (1) การให้คะแนนสัญญาณสูงในเนื้อขาวสมองตามวิธีการจัดลำดับของ Scheltens, (2) ภาวะสมองขาดเลือดอ่านตามตำแหน่ง และ (3) ภาวะเนื้อสมองฝ่อ*

ผลการศึกษา: *การศึกษาความคล้อยตามสำหรับสัญญาณสูงในบริเวณ periventricular, basal ganglia และ infratentorial foci อยู่ในระดับดีมาก สำหรับภาวะเนื้อสมองฝ่อพบว่าความคล้อยตามของสมองฝ่อส่วนกลางอยู่ในระดับดี และสมองฝ่อส่วนเปลือกอยู่ในระดับปานกลาง นอกจากนี้ยังพบภาวะสมองขาดเลือดในกลุ่มตัวอย่างแบ่งตามตำแหน่งได้ดังนี้ เปลือกสมอง ร้อยละ 15, ใต้เปลือกสมอง ร้อยละ 26, ก้านสมอง ร้อยละ 3 และใต้ส่วนคลุมสมองใหญ่ ร้อยละ 8*

สรุป: *สัญญาณสูงในเนื้อขาวสมอง เป็นหลักเกณฑ์หนึ่งที่สำคัญในการให้การวินิจฉัยภาวะสมองเสื่อมจากการขาดเลือด เพราะฉะนั้น วิธีการจัดลำดับการวัดความผิดปกติของเนื้อขาวสมองที่เหมาะสมจึงมีความจำเป็นมาก ในการให้การวินิจฉัยภาวะสมองเสื่อมจากการขาดเลือดที่แม่นยำ การใช้วิธีของ Sheltens มีความเป็นไปได้ อย่างไรก็ตาม การจัดลำดับการวัดความผิดปกติของเนื้อขาวสมองของ Scheltens จะใช้เวลาค่อนข้างมากในการให้คะแนน เนื่องจากมีความละเอียดสูง*