

Trail Making Test Can Evaluate the Impairment of Papez Circuit System by the Infarction of Anterior Nuclei of the Thalamus- A Case Report

Akira Tempaku

Department of Neurosurgery, Hokuto Hospital. 7-5 Inada-Cho-Kisen, Obihiro, Hokkaido, Japan

Correspondence:

Dr. Akira Tempaku

Department of Neurosurgery,

Hokuto Hospital, 7-5, Inada-cho-kisen, Obihiro, Hokkaido, 080-0833, Japan

E-mail address: tenpaku@hokuto7.or.jp

Introduction: Papez circuit contributes memory formation. Papez circuit disorder is difficult to evaluate the severity, since the appropriate estimation tool is not established. Executive function is also supported by the memory dependent behaviors. The author found that trail making test (TMT), which is known to check the executive function, can contribute the evaluation of the severity of Papez circuit dysfunction. **Case presentation:** A 78-year-old man had ischemic infarction at the anterior nuclei of thalamus. He showed the decreased cognitive function without motor nor sensory disorders. Executive function including activity of daily living (ADL) was also impaired. TMT score was markedly increased than that score, that had been obtained at two years ago. **Conclusion:** Anterior nuclei of thalamus is a component of Papez circuit. Ischemic disorder of that region brings memory disturbance. Further, ADL has been influenced by declining memory. Because of executive function depends on retrieve the memory for the sequential activities, TMT score changes clearly showed the impairment of Papez circuit function.

Key Words: Anterior Nuclei of Thalamus, TMT, Papez Circuit

Background

Cerebrovascular disorders are known to bring progressive higher brain dysfunction including memory based one. In particular, damage to the hippocampus and basal ganglia bring impaired cognitive functions without accompanying motor paralysis or aphasia.

The Papez circuit is a memory circuit network described by Papez.¹ That natural network consists of the hippocampus, fornix, mammillary bodies, anterior nuclei of thalamus, cingulate gyrus, and para-hippocampal region. This neural network governs memory formation.²

When part of the circuit components is damaged by such as hemorrhage or ischemic stroke, impairment of memory function would occur. However, critically assessing the degree of cognitive

dysfunction or memory impairment caused by stroke is difficult because of pre-onset evaluations are rarely conducted. Furthermore, quantitative assessment of impaired memory and encoding ability is still in difficult task.

The Trail Making Test (TMT) involves sequentially selecting numbers and letters according to rules. It is primarily considered an assessment tool for executive function impairment.^{3,4} Furthermore, the examination is simple to administer and allows for easy evaluation of functional deterioration or improvement. Sequential execution capabilities need the memory-based judges in each working steps.

The author experienced one case where he was able to perform higher-level brain function assessments, including the TMT. Which was performed prior and posterior to a cerebral infarction in the anterior

nuclei of the thalamus. This result allowed us to evaluate the degree of functional impairment. Here, the author reports based on the evaluation results.

Case Description

A 78-year-old man had presented with sudden onset disorientation. He had a history of cerebellar infarction two years prior, with only mild residual ataxia symptoms. As part of his rehabilitation, higher brain function assessments had also been conducted. He had no changed consciousness with normal vital signs except slight higher blood pressure (140/93mmHg). There was no accompanying hemiplegia or sensory disturbance at the patient administration. Head magnetic resonance imaging (MRI) revealed an acute ischemic focus in the left anterior nuclei of thalamus (Figure 1). Conservative management with antithrombotic therapy was initiated for the cerebral infarction. The patient progressed without enlargement of the ischemic focus or new neurological deficits.

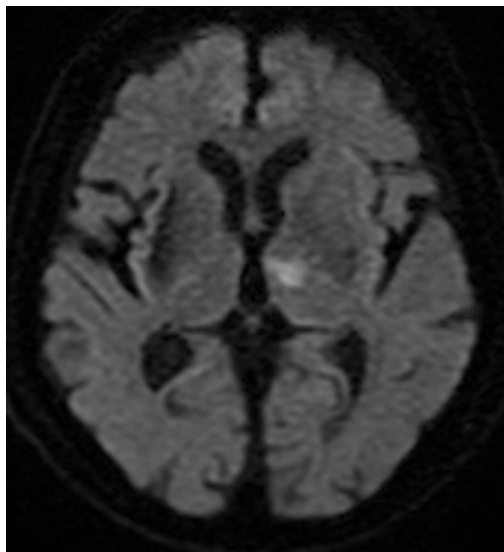


Figure 1: Head magnetic resonance imaging at the admission time. Axial plane including thalamus is taken with diffusion-weighted image. Ischemic lesion at the anterior nuclei of left thalamus is visualized to high intensity signal spot.

Higher brain function assessment showed deterioration: Mini-Mental State Examination-Japanese (MMSE-J) score decreased from 30 to 25 points, and Wechsler Adult Intelligence Scale-

Fourth (WAIS-IV) score decreased from 10 to 4 points. Additionally, the TMT-Japanese worsened from 56 to 174 seconds for Task A and from 111 to 290 seconds for Task B, with Task B also showing 2 errors. The Kohs test score decreased from 62 to 40 points, and the IQ assessment dropped from 81 to 70. Each score previously marked were obtained at two years ago, when the patient had the cerebellar infarction.

Discussion

Memory is categorized according to its retention time into sensory memory (within one second), short-term memory (within one minute), and long-term memory (for several hours or more).⁵ Long-term memory is further divided into declarative memory (also called semantic memory or episodic memory) and non-declarative memory (also called procedural memory).⁶⁻⁸ The consolidation of declarative memory is consisted with three stages: encoding, storage, and retrieval. The Papez circuit mainly governs declarative memory. Impairment in any part of this circuit results in memory deficits.

TMT is assessed by the speed of sequentially selecting presented items according to rules. Each selection action requires recalling the specified rule and choosing the appropriate item, a process demanding both memory storage as a keeping and retrieval as an output.

In this case of thalamic infarction, TMT score showed a marked increment. The TMT is considered a test for evaluating executive function impairment. Because of it involves repeatedly recalling memorized rules, it was thought to be capable of assessing the degree of memory impairment.

In Papez circuit dysfunction, impaired encoding ability brings to a diminished in the capacity to follow rules (i.e., recall rules each action time) and apply them to working actions.

From those reasons, the TMT was identified as an evaluating tool for the higher-level cognitive dysfunction caused by Papez circuit impairment.

Conclusion:

The Trail Making Test proved useful for evaluating the impairment degrees of the memory formation, which is caused by Papez circuit dysfunction. Especially, the disability change of the anterior nuclei of thalamus derived from the ischemic infarction is clearly detected by that.

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