Neuroimaging of Frontotemporal Lobe Degeneration

13

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Abstract

Frontotemporal dementia (FTD) is a neurodegenerative disease which symptoms are the first signs of illness due to progressive nerve cell loss in the frontal and anterior temporal lobes. It represents the second most frequent form of early-onset dementia. There are three clinical subtypes: behavior variant of frontotemporal dementia (bvFTD), semantic dementia (SD), and progressive nonfluent aphasia. The neuroimagings such as MRI and SPECT help in the diagnosis of FTD on usual clinical aspects in Japan. In this chapter, the typical neuroimagings of FTD are demonstrated in each clinical subtypes.

Keywords

Frontotemporal dementia • Semantic dementia • Progressive nonfluent aphasia • MRI • SPECT

13.1 Introduction

Frontotemporal dementia (FTD) is composed of a spectrum of dementing disorders with degeneration of the frontal lobes, the anterior temporal lobes, or both. The clinical features are the progressive development of behavioral and personality change and/or language impairment. According to the criteria established by Neary et al. [1], FTD is classified into three subtypes: the behavioral variant of FTD (bvFTD), semantic dementia (SD), and progressive nonfluent aphasia (PNFA).

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FTD is a common cause of early-onset dementia in individuals younger than 65 years [2]. Population prevalence estimates are in the range of 2–10 per 100,000. Approximately 20–25% of cases of FTD occur in individuals older than 65 years. FTD accounts for about 5% of all cases of dementia in unselected autopsy series. Prevalence estimates of bvFTD and SD are higher among males, and prevalence estimates of PNFA are higher among females [3].

Diagnosis of FTD is demanded in the presence of behavior and language changes. However, those features are the most silent. Therefore, the neuroimaging is useful to define those disorders and identify characteristic patterns of frontotemporal atrophy on structural neuroimages and hypoperfusion on functional neuroimagings on early stages of FTD.

In this chapter, the author demonstrates the characteristic pattern of neuroimages in each subtypes of FTD.

13.2 Neuroimaging Associations with Clinical Subtype

13.2.1 Behavioral Variant Frontotemporal Dementia

The behavioral variant of frontotemporal dementia (bvFTD) is the most common of the FTD. Individuals with bvFTD present with varying degrees of apathy or disinhibition. They may lose interest in socialization, self-care, and personal responsibilities or display socially inappropriate behaviors. Insight is usually impaired, and this often delays medical consultation. Individuals may develop changes in social style and in religious and political beliefs, with repetitive movements, hoarding, changes in eating behavior, and hyperorality. In later stages, loss of sphincter control may occur. Cognitive decline is less prominent, and formal testing may show relatively few deficits in the early stage. Common neurocognitive symptoms are lack of planning and organization, distractibility, and poor judgment. Deficits in executive function, such as poor performance on tests of mental flexibility, abstract reasoning, and response inhibition, are present, but learning and memory are relatively spared, and perceptual motor abilities are almost always preserved in the early stages [4].

The structural neuroimagings show distinct patterns of atrophy, which are in both frontal lobes (especially the medial frontal lobes) and anterior temporal lobes, in bvFTD [5]. MRI is preferred to CT in detecting these findings. However, we should keep in mind that the structural changes are not necessary present in all cases or at very early stages of disease. Follow-up studies are sometimes useful to demonstrate that the frontal and anterior temporal atrophy is progressive [6].

The functional neuroimagings demonstrate cortical hypometabolism and/or hypoperfusion in the predominant frontal or frontotemporal [7, 8], which may be present in the early stages of disease in the absence of structural abnormality [7]. The functional imaging studies using ratings or group-averaged findings suggest that predominant frontal or frontotemporal hypometabolism or hypoperfusion may aid in the differential diagnosis of bvFTD [9–22] (Fig. 13.1a–c).

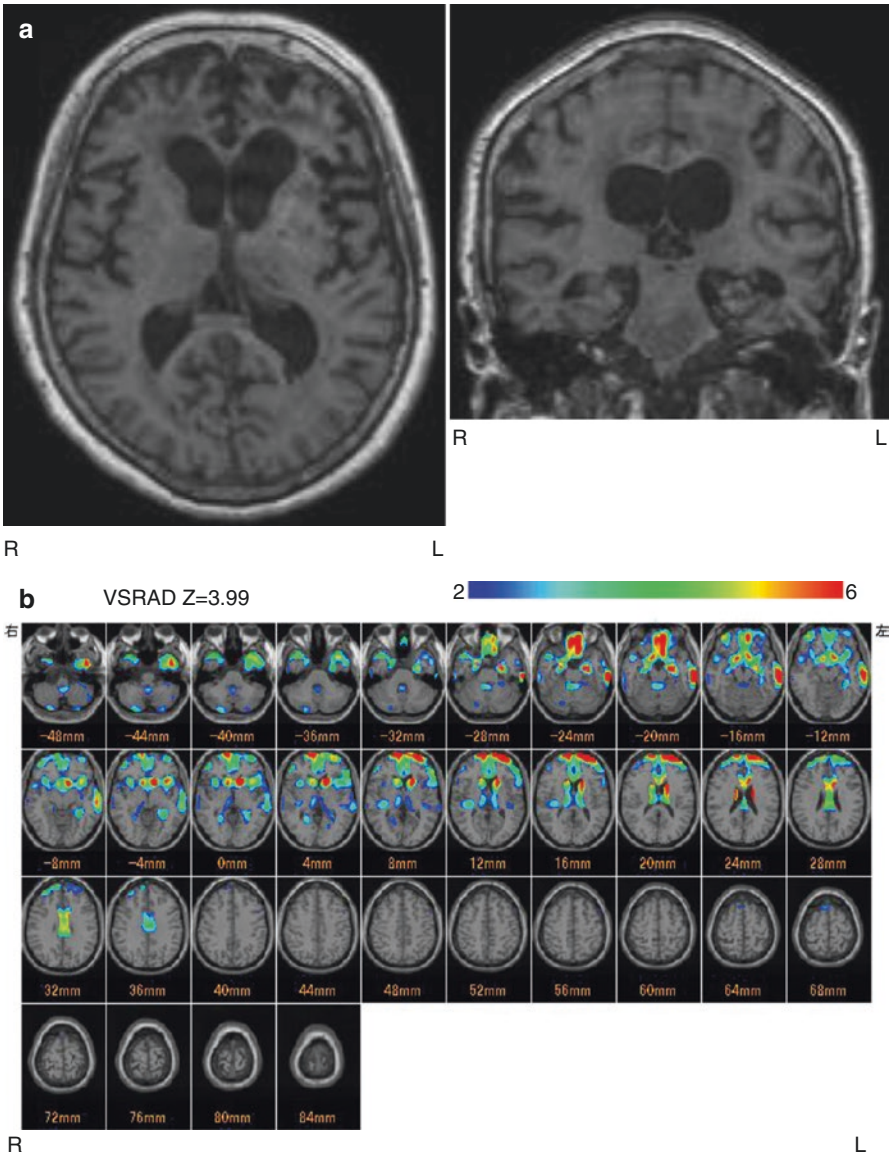


Fig. 13.1 (**a**) MRI (T1) images of bvFTD. The axial (*left*) and coronal (*right*) images demonstrate frontotemporal atrophy. (**b**) The result of VSRAD analysis (normal healthy volunteers vs. bvFTD individual). The colored areas show the regions with atrophy in the bvFTD individual compared with the normal healthy volunteers. (**c**) ^{99m}Tc-ECD SPECT images of bvFTD individual. The axial views demonstrate frontal and anterior temporal hypoperfusion. (**d**) The result of eZIS analysis (normal healthy volunteers vs. bvFTD individual). The colored areas show the regions with hypoperfusion in the bvFTD individual compared with the normal healthy volunteers

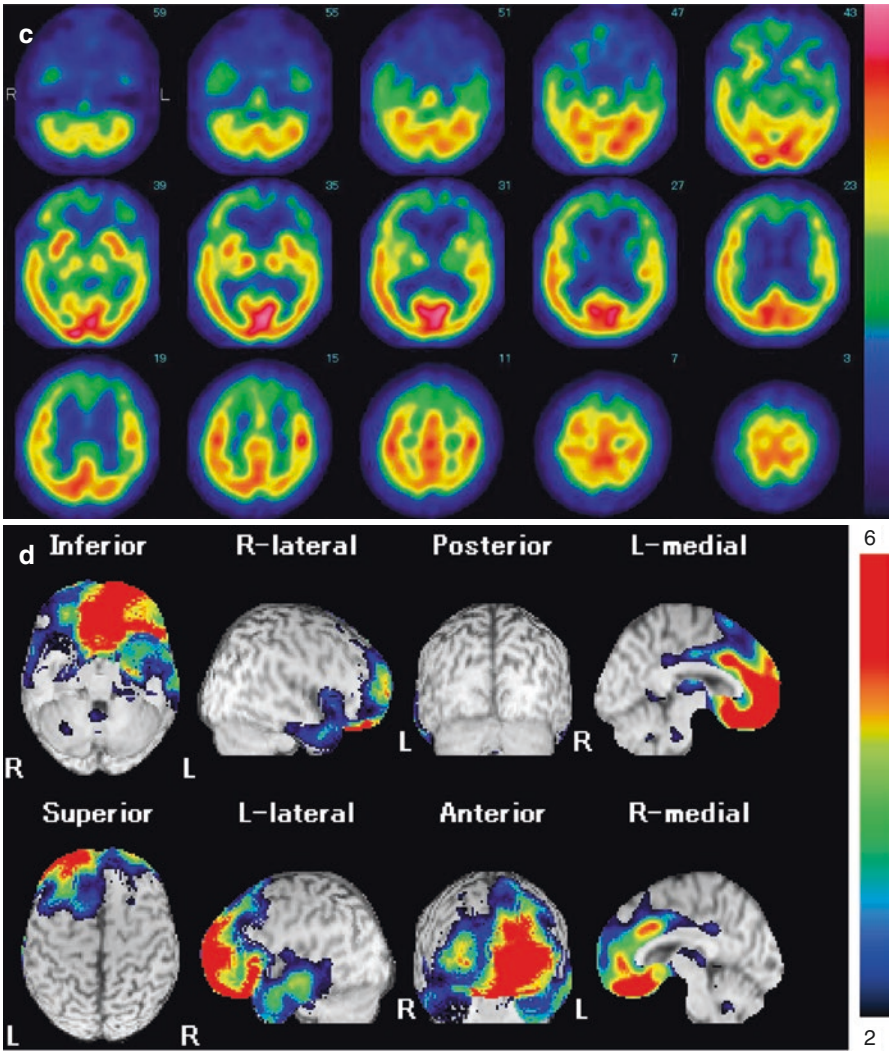


Fig. 13.1 (continued)

13.2.2 Semantic Dementia

Warrington reported three cases with associative agnosia and a fluent-type aphasia characterized by anomia and impaired word comprehension attributed to circumscribed asymmetric atrophy in the anterior temporal lobe, which was considered a selective impairment of semantic memory. Also, this feature was described by Snowden et al. as semantic dementia (SD) [23]. Later, Hodges et al. provided a comprehensive characterization of SD [24]. In 1998, Neary et al. developed diagnosis criteria for SD in relation to frontotemporal lobar degeneration (FTLD) [1].

The diagnosis of SD required a gradually progressive language disorder characterized by fluent, empty, spontaneous speech, loss of word meaning manifested by impaired naming and comprehension, preserved single-word repetition, and preserved ability to read aloud and write down orthographically regular words that are dictated [25]. Instead of the language disorder, individuals with prosopagnosia (impaired recognition of identity of familiar faces) and/or associative agnosia (impaired recognition of object identity) could also be diagnosed as having SD. Other aspects of cognition could be intact or relatively well preserved. Behavioral and personality changes characterized by loss of sympathy and empathy, narrowed preoccupations, and parsimony are included in the supportive diagnostic features, as these changes are considered characteristic of SD and often associated with high diagnostic specificity.

The neuroimaging shows atrophy and hypometabolism and/or hypoperfusion in the middle, inferior, and anterior temporal lobes bilaterally but asymmetrical, with the left side usually being more affected [14] (Fig. 13.2a–c).

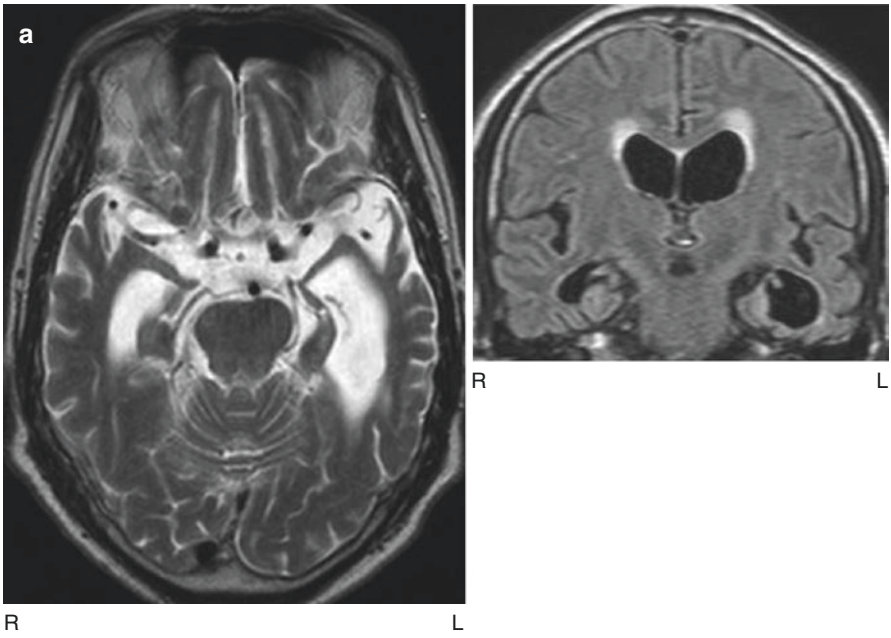
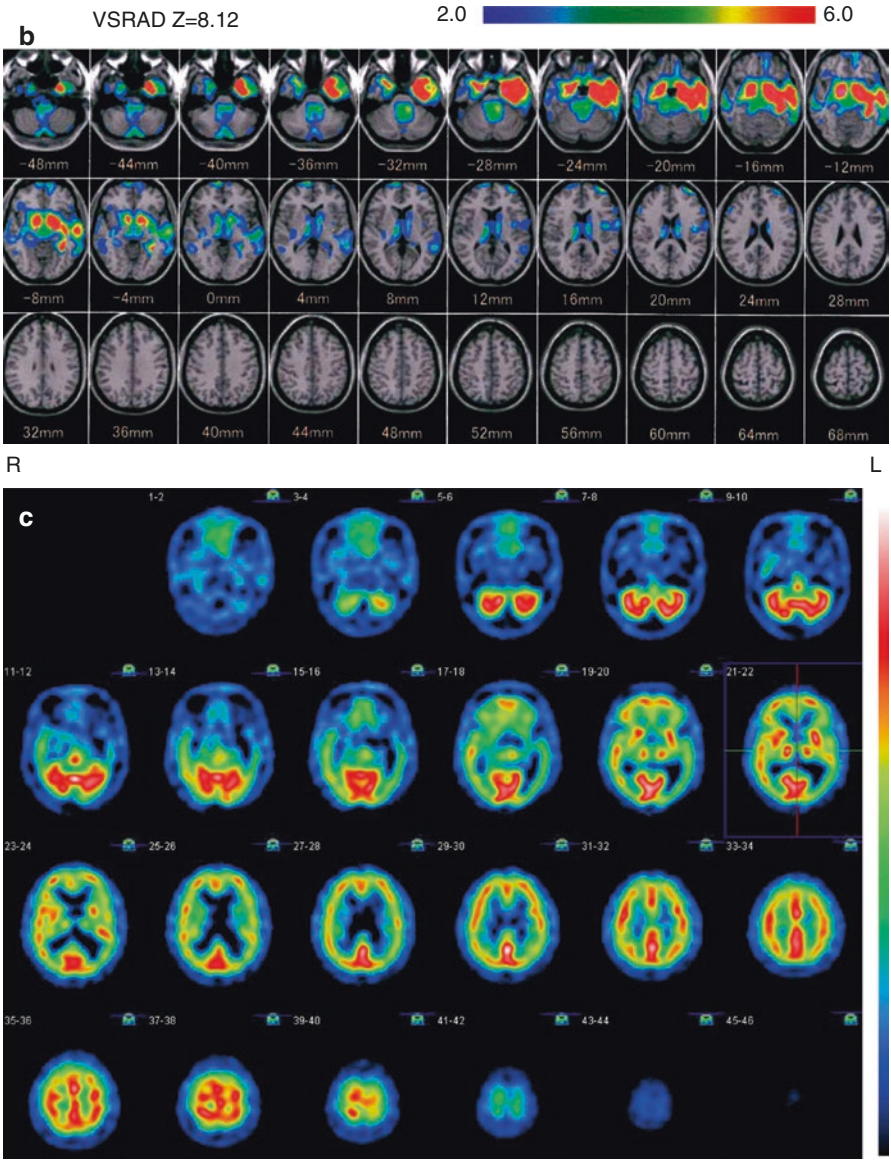


Fig. 13.2 (**a**) MRI (T2: *left*, axial) and (FLAIR: *right*, coronal) images of SD. There is bilateral anterior temporal atrophy disproportionately affecting the left temporal lobe. (**b**) The result of VSRAD analysis (normal healthy volunteers vs. SD individual). The colored areas show the regions with atrophy in the SD individual compared with the normal healthy volunteers. (**c**) ^{99m}Tc-ECD SPECT images of SD individual. The axial views demonstrate bilateral temporal hypoperfusion disproportionately affecting the left temporal lobe. (**d**) The result of eZIS analysis (normal healthy volunteers vs. SD individual). The colored areas show the regions with hypoperfusion in the SD individual compared with the normal healthy volunteers



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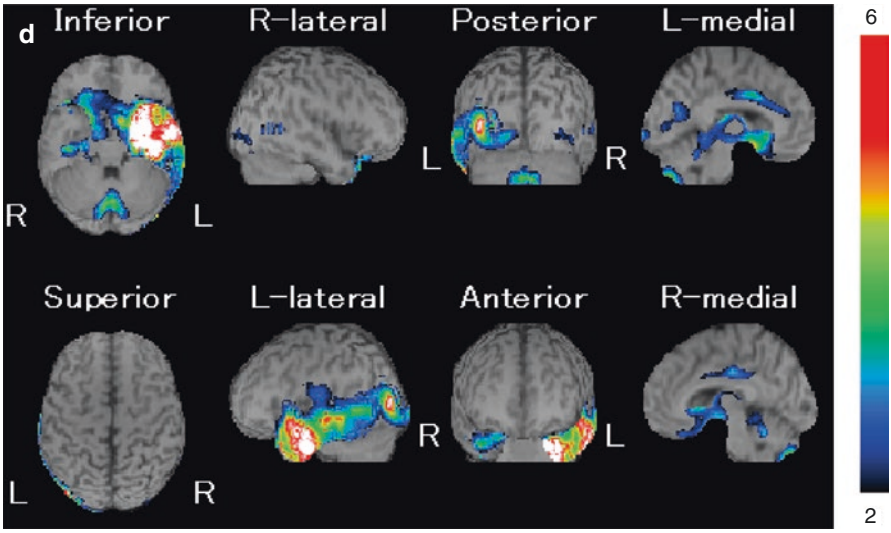

Fig. 13.2 (continued)

13.2.3 Progressive Nonfluent Aphasia

Grossmann et al. reported a different form of progressive language disorder, which was marked by dysfluent and effortful speech, hesitations, and errors in the production of speech sounds, and termed it progressive nonfluent aphasia (PNFA) [26]. In 1998, Neary et al. developed diagnostic criteria for PNFA in relation to FTLD [1].

The diagnosis of PNFA required gradually progressive nonfluent spontaneous speech with at least one of the following symptoms: agrammatism, phonemic paraphasias, or anomia [25]. Other aspects of cognition could be intact or relatively well preserved. Late behavioral changes similar to bvFTD are included as supportive diagnostic features.

The neuroimages show predominantly atrophy and hypometabolism and/or hypoperfusion in the left posterior frontal–insular region [27–29] (Fig. 13.3a–c).

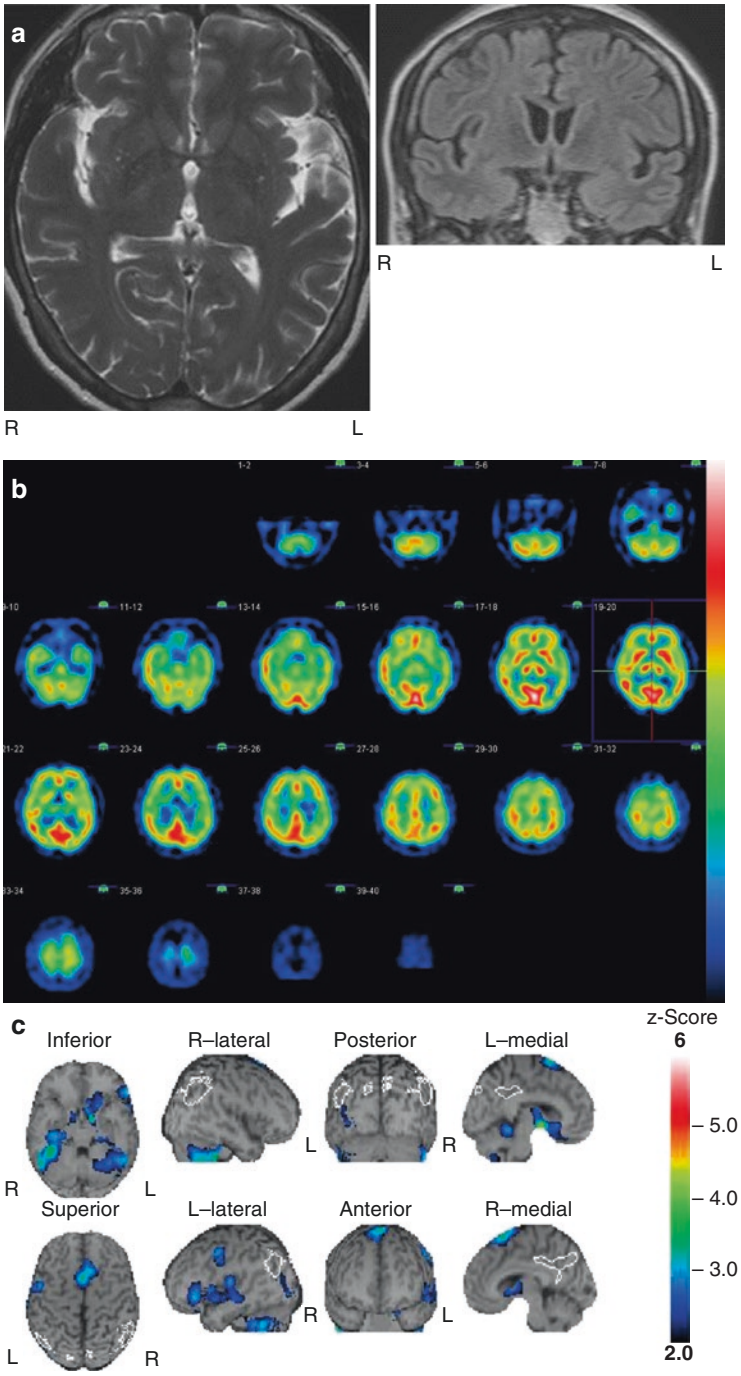

Fig. 13.3 (**a**) MRI (T2: *left*, axial) and (FLAIR: *right*, coronal) images of PNFA. The images demonstrate asymmetric atrophy of the left Sylvian fissure. (**b**) ^{99m}Tc-ECD SPECT images of PNFA individual. The axial views demonstrate asymmetric hypoperfusion in the left posterior frontal–insular. (**c**) The result of eZIS analysis (normal healthy volunteers vs. PNFA individual). The colored areas show the regions with hypoperfusion in the PNFA individual compared with the normal healthy volunteers

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