Neuroimaging in dementia

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Abstract

Neuroimaging contributes to dementia assessment by detecting structural lesions, characterizing neurodegenerative and vascular injury, identifying molecular pathology, and monitoring treatment safety. These functions require different acquisitions and support different levels of inference. Computed tomography remains useful when magnetic resonance imaging is unavailable, contraindicated, or poorly tolerated, whereas magnetic resonance imaging provides more complete assessment of regional atrophy, small vessel disease, diffusion restriction, and hemorrhagic lesions. Fluorodeoxyglucose positron emission tomography and perfusion single photon emission computed tomography characterize regional dysfunction; dopamine transporter imaging addresses nigrostriatal degeneration. Amyloid positron emission tomography identifies fibrillar amyloid burden, while tau positron emission tomography provides information about the distribution and severity of Alzheimer type tau aggregates. Neither a positive molecular scan nor an atrophy pattern independently establishes the cause of every cognitive symptom. The interpretation of imaging therefore requires integration with the cognitive phenotype, functional status, disease tempo, comorbidity, and the consequences of diagnostic uncertainty. This narrative review examines acquisition, interpretation, diagnostic criteria, differential diagnosis, tracer characteristics, quantification, and clinical algorithms. It also evaluates emerging biomarkers of synaptic density, neuroinflammation, astrocyte reactivity, microstructural injury, perfusion, blood–brain barrier dysfunction, susceptibility, and network organization. Particular attention is given to biological versus clinical definitions of Alzheimer disease, the limitations of early tau detection, and the distinction between amyloid clearance and clinical benefit. Imaging for antiamyloid therapy introduces an additional requirement: reproducible magnetic resonance surveillance for amyloid related imaging abnormalities. Future clinical adoption of emerging measures depends on analytical reproducibility, external validation, representative populations, and evidence that their use improves decisions or outcomes.

Keywords: dementia; magnetic resonance imaging; computed tomography; positron emission tomography; amyloid; tau; imaging biomarkers