SPECT in cerebrovascular disease

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Technology: Single-photon emission computed tomography (SPECT)

Use: Brain SPECT uses a fast rotating gamma camera to detect photons emitted by tracer molecules trapped in brain tissue. Modern cameras with multiple receivers (“heads”) improve the resolution to 7–8 mm and allow a scanning time of about 20 minutes. Quantitative measurement of regional cerebral blood flow is possible with xenon-133. Two technetium-99m–based tracers are currently in use: hexamethylpropyleneamine oxime and ethyl cysteinate dimer. However, these agents are suitable only for semiquantitative measurement of brain perfusion because they provide a relative flow distribution with reference to the cerebellum. These agents are retained in the brain tissues for a relatively long time; therefore, scanning can be delayed up to a few hours, and the images will still represent brain perfusion at the time of tracer injection.

In addition to investigation of cerebrovascular disease, SPECT has been used to investigate epilepsy and cerebral degenerative disease. New applications include selective receptor-binding tracers. We will describe the clinical application of SPECT in patients with cerebrovascular disease.

History: SPECT was introduced in the 1970s to measure regional cerebral blood flow noninvasively using radioactive isotopes. This new technology emerged to improve spatial resolution of gamma cameras and the imaging qualities of radiopharmaceutical tracers. Clinical multicentre trials were performed to establish the utility of each tracer for specific clinical applications, including stroke and dementia, and this technology is currently in widespread clinical use.

Promise: SPECT is performed in patients with cerebrovascular disease to localize the ischemic lesion, to predict lesion volume, early deterioration and stroke outcome, to evaluate the capacity of brain arterioles to dilate after intravenous injection of acetazolamide and to monitor thrombolysis-induced reperfusion (Figure), surgical interventions and other therapies. SPECT can also help in the differential diagnosis of degenerative diseases by showing decreased tracer uptake in the frontal or temporal lobes specific to various forms of cognitive disorder.

Problems: SPECT is an ancillary test to CT or MRI in select patients. CT is required for initial diagnostic workup of patients with cerebrovascular disease and stroke. MRI offers advantages of both structural and perfusion imaging. SPECT shows only perfusion linked to a single tracer distributed in the brain. Although good-resolution SPECT can be accomplished within 25 minutes, it cannot replace CT when investigating patients with acute stroke, because time is an issue.

Prospects: SPECT can be used in select patients with focal cerebral ischemia in addition to CT or MRI to determine the location and mechanism of ischemic damage; brain perfusion changes after vasodilatory stimuli to identify patients with exhausted collateralization capacity in the presence of carotid occlusion; and brain perfusion changes after therapies to improve cerebral blood flow. New technologies of white cell labelling may help to identify intracranial thrombosis using brain SPECT. In patients with cerebral degenerative disease, SPECT can further improve the differential diagnosis, particularly with the new selective receptor-binding tracers.

Competing interests: None declared.

References

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