Ischemic Stroke – Serious, but not Hopeless
A View from the Heidelberg School of Neuroradiology

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Abstract
Patients at risk of disabling stroke or death from stroke may present asymptomatic, with transient ischemic attack or minor stroke, or with acute disabling stroke. In all these patients, the diagnostic work-up of vascular and brain pathology is crucial to determine the immediate risk of brain damage and permanent disability. Neuroradiology has the means to quickly gain this information and thus to guide stroke patient management.

Key Words: Cerebral Ischemia · Ischemic Stroke · Stroke Imaging · CT · MRI

Zerebrale Ischämie – ernst aber nicht hoffnungslos. Eine Sicht der Heidelberger Neuroradiologieschule

Zusammenfassung

Schlüsselwörter: Zerebrale Ischämie · Schlaganfall · Multimodales Imaging · CT · MRT

Introduction
Ischemic stroke may cause severe disability and death, if not prevented or treated in time. This article outlines the important role of neuroradiology in acute stroke management.

When examining asymptomatic patients at risk of stroke, patients with transient ischemic attacks (TIAs), and patients with completed disabling stroke, imaging of the brain and supplying vessels is crucial. Brain, vascular and functional imaging have the capability to assess individual risks and chances for recovery by distinguishing stroke from stroke mimics, by identifying the type and often also the cause of stroke, and may help to differentiate irreversibly damaged tissue from areas that may recover thus guiding emergency management and subsequent specific treatment, and may thus help to predict outcome. Vascular imaging may identify the site and cause of arterial obstruction, and identifies patients at high risk of stroke recurrence for specific preventative treatments. Functional imaging can directly assess patterns of brain perfusion disturbance and the capacity of cerebral perfusion reserve thus identifying arterial obstruction causing critical hypoperfusion.

Clinical Efficacy of Diagnostic Imaging
In deciding when and how to order imaging investigations, it should be considered, to what extent the imaging results will affect the patient’s care and what type of
imaging modality the patient can tolerate. Diagnostic imaging in acute stroke may impact on different levels of diagnosis and management, but should be used judiciously [1]. Brain imaging may reduce health-care costs by preventing disability and death after stroke through correct diagnosis of patients and exclusion of stroke mimics, resulting in the use of the appropriate treatment for patients with acute neurologic deficit from other causes, and the use of specific treatments in patients with stroke, e.g., reperfusion strategies. Diagnostic imaging must be accurate in detecting stroke pathology at the time when a specific treatment is effective, e.g. within 3 h of stroke onset, should provide reliable images, and should be technically feasible and safe in acute stroke patients.

**General Principles**

Stroke units should provide brain imaging on each day of the week and for 24 h per day. Acute stroke patients should have a clear priority for brain imaging compared to other patients, because time limits are so crucial. Imaging tests should be scheduled in parallel with emergency medical management and take the patient’s condition into account. Many patients with major, potentially disabling stroke can be managed on the basis of computed tomography (CT), and a substantial proportion (up to 45%) of these patients may not be able to tolerate magnetic resonance (MR) examination because of their medical condition [2–4]. In many patients with moderate to severe acute disabling stroke, diagnostic brain imaging must be performed without delay on arrival at a hospital so that treatment can be started immediately. Diagnostic brain imaging is important also in patients with TIA of whom up to 10% will

**Figures 1a to 1c.** A 57-year-old woman with arterial hypertension and smoking habit had a checkup with carotid Doppler ultrasound. She was sent to MRI, because the right common carotid artery was missing (a). To assess the clinical relevance of common carotid artery occlusion, we obtained a time-to-peak map on MRI after contrast bolus injection (b). Contrast inflow was delayed into the right ACA and MCA territory. To further evaluate the risk of stroke, we measured the cerebral perfusion reserve using the blood oxygen level-dependent (BOLD) contrast after short periods of breath holding (c). The cerebral perfusion reserve was not impaired, because common carotid artery occlusion was fully compensated by collateral blood flow.