Measuring brain oxygen levels with light – A new method of diagnosing stroke

Lars Edvinsson, Professor at the Department of Experimental Vascular Research, is world renowned for his research on migraine. His research on calcitonin gene-related protein (CGRP), and its connection to migraine, has resulted in a new antibody treatment which is close to approval for use in the clinics. In addition, he was recently announced as the new president of the International Headache Society (IHS), an organization of scientists with a research focus on headache disorders.

In parallel to his research on migraine, Lars Edvinsson has also put a lot of effort into researching stroke; research which has been ongoing for over 20 years. In collaboration with technicians from the Department of Atomic Physics, Lars Edvinsson is eager to initiate research which could provide a new method to quickly diagnose stroke.

Stroke is a cardiovascular disease categorized as either ischemic (poor blood supply) or hemorrhagic (bleeding). The result of either type of stroke is poor oxygenation of the brain, which ultimately causes nearby cells in the area to die. Depending on the location of the damage, the patient will risk developing various disorders, such as irreversible impairments to the motor and cognitive functions.

CT-scans and MRI methods used for diagnosing stroke. Albeit CT-scans and MRI can provide reliable imaging and diagnosis of stroke, the methods are not flawless; Ct-scans use ionized radiation and MRI affects metallurgic devices, and both require the use of big machines. There is a need for additional methods which can provide a similar level of diagnostics, but which provide an increased safety for the patients and is more portable.

The new method, currently in early development, is a laser based technique which utilizes a rare earth crystal capable of slowing down light. Roughly, when light is sent through the crystal it is slowed down roughly 10 000 times (from 300 000 km/h to 3 km/h). This results in alterations of the characteristics, such as penetration, of the light and enables it to travel through the skull bone. A specific wave length is then sorted out for detecting oxygen. It would then be possible to measure the oxygen levels in the brain. Here, the patients who have suffered a stroke would show lower oxygen levels in the brain compared to healthy individuals.

The goal is not to replace the current methods used for diagnosing stroke, but rather to provide an additional method to support the current ones. The laser could increase the possibility of providing a quick answer to whether the patient has suffered a stroke or not. If the patient has suffered a stroke they can be further evaluated with CT or MRI to find the location of the stroke lesion in the brain. The same goes for ruling out the possibility of a stroke in a patient who is only displaying similar symptoms.

In addition to the laser crystal method, photo acoustic imaging (PAI), another laser imaging method, is also in the testing stages of investigating cardiovascular diseases, more specifically heart diseases. In the case of PAI, the interest is to identify structural changes in the heart, such as heart muscle thickness, but could potentially be applied to detect stroke caused by embolic infarction in the heart.
Since the crystal laser method is in its initial testing stages in animal models, it’s difficult to anticipate the challenges and difficulties with the method. However, Lars Edvinsson is positive to the challenges ahead, underlining that where there is a challenge there is new knowledge to be gained.

- When I was a student, I asked my professor in neuroanatomy if it was possible to conduct research in the field. He replied with “All the big findings have already been made”. But he was wrong. Despite the huge leap of progress in the field, we still don’t know the extent of knowledge which remains unknown to us, says Lars Edvinsson.

- Joakim Hising