Doctoral dissertation studies the use of light in measuring cerebral circulation

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Tiina Näsi, a researcher of biomedical engineering at Aalto University, studied in her doctoral thesis the use of light in measuring the brain's blood circulation. This optical measurement may in the future help discover the cause of sleep disorders as well as their close connection with cardiovascular diseases. The method is currently being tested in a hospital.

In optical recording, light is fed to the test subject's head via an optical fiber, for example through the subject's forehead. Light travels and changes direction in the brain and some of it also exits the head. The light that has traveled in the brain can thus be measured with another optical fiber just a few centimeters from where it was fed to the subject's head.

"Light travels through body tissue in the same way that for example a flashlight shows through the hand," explained Tiina Näsi.

"The measuring signal registers changes in the cerebral blood circulation, which are often signs of neural activity. Therefore, changes in blood circulation indicate which areas of the brain are active."

Monitoring natural sleep

Cerebral circulation can also be measured with functional magnetic resonance imaging but optical measuring enables longer monitoring

periods and the research of natural sleep. This is difficult to achieve with functional magnetic resonance imaging, as the device is quite loud and the test subject must lie completely still.

The device used for optical measuring is small and movable, whereas functional magnetic resonance imaging is done with a heavy device in a shielded room. The optical power used in the measurement is low and the heat transferred to the brain tissue corresponds to the heat of sunlight on a sunny day. Despite these advantages, optical measuring is not widely used in hospitals, as it measures complex phenomena, which are sometimes difficult to interpret. Näsi's thesis aims at facilitating the use of optical measuring in practice.

"I made use of the advantages of optical measuring in my thesis. We monitored the sleep of some 15 healthy test subjects for altogether 30 nights and were able to measure changes in their cerebral circulation at different stages of sleep. The hospital environment reduced the quality of their sleep, so we were also able to monitor the effect of unstable sleep to cerebral circulation," said Tiina Näsi.

Optical method put to hospital test

The optical measuring of sleep is currently being tested in a hospital on patients suffering from sleep disorders. The aim is to find out how sleep disorders influence the cerebral circulation and whether people suffering from them manifest similar changes in their cerebral circulation as the healthy test subjects who slept intermittently during monitoring.

"Sleep disorders seem to be closely connected to cardiovascular diseases, and I hope that optical measuring will help us understood the connection. Doctors are very interested in this research and hopefully it will bring about a better understanding and eventually also new treatments to sleep disorders," said Tiina Näsi.

Optical measuring may in the future also help monitor the brain development of newborn babies more reliably as well as detect cerebral hemorrhage caused by childbirth. The method is ideal for small children as a child's small head and thin skull allow light to travel longer in the brain, and the test subject is not required to lie completely still during the measuring.

The effects of magnetic stimulation

In the second part of her doctoral thesis, Tiina Näsi studied the changes in cerebral circulation caused by transcranial magnetic stimulation, which is used for example in treating depression. The aim of the research was to better understand the effects of magnetic stimulation and to enable more effective treatment.

"Studying magnetic stimulation with the optical method requires further research before we can achieve completely reliable results. Transcranial magnetic stimulation creates physiological disturbance in optical measurement, and more work is needed before we are able to distinguish the disturbance from the actual signal. My thesis concentrates on the challenges of the research as well as on how they could be solved," said Näsi.

Optical measuring and its practical applications will be needed in the future.

"Brain disorders become more common as the population ages. We need safe, affordable and easy-to-use methods for researching brain activity and blood circulation," said Tiina Näsi.

More information: lib.tkk.fi/Diss/2013/isbn97895 … sbn9789526050706.pdf

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