Epilepsy is a set of neurological disorders affecting about 1% of the worldwide, as well as in Swedish population. This group of disorders is characterized by recurring seizures, which are caused by overexcitability in the neurons of the brain. In children, epilepsy has detrimental effects on the development of the brain, which usually results in regression in the child’s ability to speak and learn. Epilepsy in children is also often resistant to current treatment. My Andersson, one of Principal Investigators at the Epilepsy Centre, IKVL, Lund, is investigating the biological changes in the brain during childhood epilepsy and new treatment options to prevent the onset of the disorder.

Epilepsy usually appears as a result of an insult, such as stroke, or damage to the brain. In children, the injury can occur years before the first epileptic seizures begin to show. In My Andersson’s current project, she is investigating the use of induced pluripotent stem (iPS) cells as new treatment strategy for epilepsy. The project involves a mouse animal model, which mimics the late onset of epilepsy similar to that in humans, as well as resected brain tissues from young epilepsy patients.

“The mice start to show epileptic seizures roughly 6 months after birth, a timepoint where we consider the animals to be epileptic”, says My Andersson.

Since epilepsy can result from a variety of reasons, My Andersson has tested a number of approaches to address different causes of epilepsy. One approach is the use of induced pluripotent stem (iPS) cells to restore lost neurons, particularly the gamma-aminobutyric acid (GABA) producing neurons, which can reduce the overexcited state of the brain. In addition, My Andersson, in collaboration with other groups in Epilepsy Center, also looked at whether xenografted human iPS cells can successfully connect to the synaptic network of the rodent brain, and currently is investigating whether iPSCs can contribute to a reversal of diseased brain to healthy development in juvenile animals.

“If stem cell therapy is to be used to treat children with epilepsy it’s important that the new neurons not only take on the role of the cells they are replacing, but also connect to the surrounding network of the brain and support its development”, says My Andersson.

Treatment strategies, which are found to be effective in the mouse animal model, can then be translated to the resected brain tissue from amygdala and hippocampus (common starting points for epilepsy) obtained from young patients with epilepsy. Thanks to new preservation methods (developed together with Prof. Merab Kokaia’s group in Epilepsy Center, as collaboration between Lund University Hospital, Copenhagen University and Copenhagen University Hospital) which mimics the natural environment of the brain, human brain tissue can be kept alive for much longer time. This has been a great advancement when evaluating new approaches to treat epilepsy, especially the treatment options which require longer time to show any effect.

“Previously the donated brain tissue could be kept alive for around 12 hours at most during an experiment. Now, the same brain tissue can be used for up to 48 hours”, says My Andersson.

Other research teams across the world have also looked into different approaches to use devices, which can detect and prevent seizures before they occur. My Andersson and Merab Kokaia have
worked with a similar approach, optogenetics, which utilizes the gene expression and implanted optic fibers to control excitability of neurons with light.

“In my postdoctoral project in Merab Kokaia’s group, we were able to transflect light-sensitive proteins to culture human brain tissue from patients and control the proteins with light for up to 3 weeks”, says My Andersson.

Despite the many new approaches to treat epilepsy described above, My Andersson states that we probably won’t see any clinical trials with these treatments in another 15 years; even longer for trials involving children with epilepsy. She is still very positive to the variety of approaches being investigated, since the underlying causes to epilepsy are many.

“Something I think would be of great benefit for epilepsy research would be the ability to culture brain tissue from patients in a secure and continuous way. This would be of great help when trying to determine the causes of epilepsy and which treatment should be applied”, says My Andersson.

- Joakim Hising