Investigation of the influence of radiotherapy on the oxygen supply and the activity of brain tissue.

The human brain plays a crucial role in the regulation and coordination of various bodily functions. It requires up to 20% of the total energy of the body to carry out its complex operations. This makes the brain the most energetically demanding organ of the body. When the brain tissue wants to produce more energy, it can primarily use two mechanisms. Either it increases the blood flow, or it can increase the amount of oxygen it extracts from the red blood cells. Usually in healthy tissue, the blood flow and the amount of used oxygen is perfectly balanced. This balance of blood flow and amount of used oxygen can be described as the 'activity' of the tissue. However, in patients with brain tumors, the blood flow, amount of oxygen extracted and therefore the 'activity' changes. In tumor tissue, for example, new vessels grow very fast with inconsistent diameter, abnormal bends and occasionally dead-ends. This results in some areas inside the tumor which may not get enough blood supply and therefore those areas should have to increase the amount of oxygen they get from the blood cells to carry out their tasks.

Often radiotherapy is used to kill a tumor. However, the radiation often also damages healthy tissue, especially the blood vessels. As a result, the vessels may not be able to increase the blood flow anymore when needed and thus, if the healthy tissue needs more oxygen, it has to receive more oxygen from the red blood cells. Changes in the oxygen supply to the tissue can be picked up with an MRI scanner. The scanner identifies the change in the amount of oxygen-carrying blood cells in the brain. When the brain uses more oxygen, there will be less oxygen-carrying blood cells in the veins.

In this research, we will investigate what the difference is in healthy tissue versus tumor tissue. We will describe the differences in terms of the 'activity' and the change in amount of oxygen-carrying blood cells. Next to that, we will also investigate the effects of radiotherapy on the healthy- and tumor tissue by scanning the patients before- and a few months after radiotherapy. The results of both scans will be compared to describe the effects that radiotherapy has on the healthy- and tumor tissue.

The results show that the brain, excluding the tumors, is more active after radiotherapy. We expected that this would happen, since the brain tissue was damaged by the radiotherapy and is trying to repair itself. Next to that, we found that tumor tissue uses less oxygen compared to healthy tissue. However, because the strangely-formed blood vessels are not close to all tumor cells, we expected that tumor tissue would get more oxygen from the red blood cells to give all tumor cells enough oxygen. This difference in our expectations is probably due to a change in the way that the tumor cells produce energy, which typically uses less oxygen. Finally, we found that the amount of radiation does not change the 'activity' of the tissue or a change in oxygen-carrying blood cells. This can be explained by the fact that the brain tissue is indeed damaged by the radiotherapy, but that the brain is capable of tweaking the blood flow or the amount of oxygen it takes from the blood cells in order to keep the 'activity' stable.

In conclusion, we were able to describe the relationship of oxygen use and the amount of 'activity' in both healthy tissue and tumor tissue, and their changes after radiotherapy.